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AN UNUSUAL DIMORPHISM IN STREPTOPOGON CALYMPERES C. MUELL. EX GEH. (MUSCI; POTTIACEAE)

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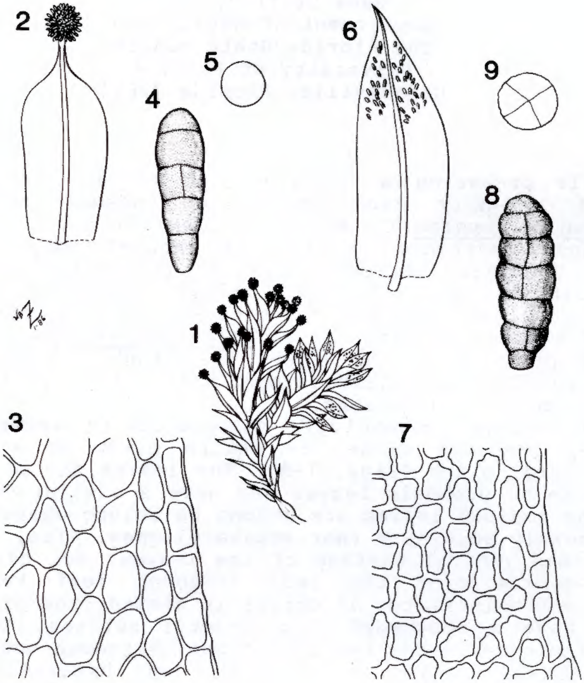
While preparing a flora to the mosses of the Venezuelan paramos, I recently came across an unusual growth form in *Streptopogon calymperes* C. Muell. ex Geh. which, to my knowledge, has not been described before. The normal morphology in this widespread tropical American species is unmistakable. Although rarely fruiting (cf. Griffin, 1979), plants are immediately recognizable by the "pom-pom" like clusters of gemmae borne at the end of what earlier authors called *folia proboscidea*. In such leaves the apical portion of the blade is abruptly contracted into a snout-like subula with a bulbous apex that serves as a platform from which the gemmae are dispersed.

The unusual morphology, discovered in several Venezuelan collections, involves either an entire plant or a branch of an otherwise normal plant (Figs. 1-9). The leaves are of approximately the same size as probosis leaves and have a similar costal anatomy; however, the unusual leaves are oblong to oblong-obovate and have an acute to shortly acuminate (not subulate) apex. Also, the gemmae are borne over the ventral surface of the leaves, not clustered at the tip. The gemmae from the less frequent leaf type are often 4-seriate, not uniseriate, as occurs in gemmae from probosis leaves, and often have a roughened (not smooth) surface. There is still another difference in the two leaf types. Although both types have a similar basal areolation (basal cells lax, hyaline, thin-walled), the upper laminal cells of the two types are different. In normal leaves the upper cells are hexagonal to oblong-hexagonal and relatively thin-walled. These cells average about 20 µm in width. In "abnormal" leaves the upper cells are rounded-subquadrate, incrassate and average about 10-15 µm in width.

Foliar dimorphism is not particularly rare in mosses, but I am not acquainted with any other gemmiferous moss in which dimorphism approaches that reported here or takes this particular form. Probosis leaves are not uncommon in various species of Calymperaceae, and in these it often occurs that the costa of probosis (gemmiferous) leaves is stouter and sometimes more papillose-spinose than in non-gemmiferous leaves, but in the present case both leaf types are gemmiferous.

It will not be lost on some readers, nor was it on the author, that what might be involved here are two different species. I entertained that notion for a period of time, but, in one of the collections examined (Griffin *et al*. 116), there is a plant bearing both leaf types, the abnormal leaves being restricted to a lower



Figures 1-9. Streptopogon calymperes. --1. Habit, x 6 (left-hand branch bearing "abnormal" leaves). --Figs. 2-5. From "normal" plant. --2. Leaf, x 20. --3. Upper laminal cells, x 500. --4. Gemma, x 265. --5. Gemma, cross-section, x 265. --Figs. 6-9. From "abnormal" branch. --6. Leaf, x 20. --7. Upper laminal cells, x 500. --8. Gemma, x 265. --9. Gemma, cross-section, x 265. All drawings made from Griffin et al. 116.

branch. After reflection, I have come to accept this second morphology as simply part of the phenotypic expression of which Streptopogon calymperes is capable.

Specimens examined: VENEZUELA. Mérida. El Valle road, NE of Mérida (city), Griffin, López & Ruiz-Terán 13, 633, La Pedregosa, tributary of the río Chama, Griffin, López & Ruiz-Terán 763, Parque La Isla (City of Mérida), Fransén 1360. Táchira. Páramo de Tamá, Griffin, López & Ruiz-Terán 115, 116. (All FLAS).

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Appreciation is also expressed to Wendy Zomlefer for the illustrations that accompany this paper.

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SPHAGNUM OF THE SOUTHWESTERN CATSKILLS,
HANCOCK TOWN, DELAWARE COUNTY, NEW YORK

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INTRODUCTION

This is a record of the peat mosses (Sphagnum) collected in Hancock Town, Delaware County, New York, on the southwestern fringe of the Catskill Mountains, between 1975 and 1985.

The Catskill region is actually a deeply dissected plateau topped with porous gray sandstone. Streams in the area covered in this paper either drain north into the East Branch of the Delaware River, or south into the (joined) Delaware River, which there forms the political boundary with Pennsylvania.

Sphagnum usually occurs in mires, defined as wetlands where peat is forming; according to Andrus' (1980) classification of mire types, Catskill mires are commonly poor fens. In Hancock Town, rich Sphagnum habitats include extensive, wooded, perched water table swamps, edges of the few glacial kettle lakes (Delaware Lake, Basket Lake, Sand Pond, Pierce Pond and Somerset Lake), the Hungry Hill Bog, and wet spots in woodlands, old fields or along roadsides.

METHODS

Sphagnum collections were made as part of a general floristic survey of wetlands in the area covered. Most specimens mentioned in this paper were collected from three localities, which are briefly described below.

(1) BOUCHOUX'S SWAMP: French Woods, 300-950 feet W of Dirig Road, and extending from State Road 97 on the S for 1400 feet to the N; ca. 1770 feet.

This large mire was originally heavily wooded with *Tsuga canadensis, Pinus strobus, Betula alleghaniensis, Fraxinus nigra* and *Acer rubrum*, with *A. pensylvanicum, A. spicatum, Ilex verticillata, Rhododendron maximum* and *Lindera benzoin* frequent understory shrubs. Other characteristic plants included *Clintonia borealis, Cypripedium acaule, medeola virginica, Cornus canadensis, Saxifraga pensylvanica, Polygonum arifolium, Veratrum viride, Habenaria psycodes* and *Senecio aureus*. *Goodyera tesselata, Streptopus roseus* and the lichen *Lobaria pulmonaria* were among the rarer species.

This swamp is perched on the drainage divide, with the southern outlet (Bouchoux Brook) flowing into the joined Delaware River at Bouchouxville, and an outlet on the north reaching the East Branch Delaware River via Pierce Pond. The southern half of this wetland was flooded by beavers in 1963, killing most of the large trees and shrubs within a few years. The northern half of the swamp remains more or less as it was, in sharp contrast to the adjacent beaver meadow. Intermittent beaver activity has occurred since the initial flooding. *Dulichium arundinacium* and *Phriagmites communis* first appeared in 1978, and the latter has rapidly spread throughout the open areas. *Sphagnum* is frequent, especially in undisturbed places around the edge of the mire and on hummocks.

(2) LOG CABIN MARSH: Pea Brook, 250-750 feet W of Nevins Road, 300-850 feet E of State Road 97, and extending from Cross Road on the S for 1400 feet to the N; ca. 1490 feet.

This mire, similar to the preceding in size and extent, was originally a rich, virgin *Tsuga canadensis* swamp, according to local historians. The large hemlocks were cut and their bark stripped for tannin during the last century. The valley was flooded by beavers in 1961, and now is a large beaver meadow with intermittent beaver activity still evident.

Frequent woody plants include *Pinus strobus, Tsuga canadensis, Acer rubrum, Kalmia latifolia, Ilex verticillata, Alnus incana* var. *rugosa* and *Spiraea latifolia*. Other plants present include *Habenaria psycodes, Symplocarpus foetidus, Geum rivale, Lyonia ligustrina* and *Taxus canadensis*. The least disturbed parts are on the W side, where *Sphagnum* carpets the ground.

(3) HUNGRY HILL BOG: Pea Brook, 500 feet E of Hungry Hill Road, 500 feet S of jeep trail, and 1150 feet NNW of Delaware Lake: ca. 1810 feet.

This was the only surviving *Sphagnum*/heath bog in southern Delaware County until its destruction by beavers in 1977-1978. It contained many rare plants, including a few highly significant populations for the entire Catskill region. The following species grew on the open mat: *Sarracenia purpurea, Chamaedaphne calyculata, Kalmia angustifolia, K. polifolia, Vaccinium oxycoccos, Eriophorum spissum, E. virginicum, Andromeda glaucophylla* and *Calopogon pulchellus*. Prominent plants at the edges of the mat and in the surrounding swampy "moat" were *Gaultheria hispidula, Pinus strobus, Acer rubrum, Tsuga canadensis, Calla palustris, Betula alleghaniensis* and *Osmunda cinnamonea*. This bog was a wonderful lichen habitat (*Usnea* spp., *Pseudevernia consocians, Evernia mesomorpha, Hypogymnia physoides, Platismatia tuckermanii, Bryoria furcellata* and *Cetraria pinastri*, among others), and bryophytes were very abundant. The bryological survey was incomplete at the time of flooding, so *Sphagnum* records are fragmentary. The area is presently a large beaver pond.

Cited specimens are all R. Dirig collections which have been deposited in BH, BING, NYS and my personal herbarium (=R.D.).

SPECIES LIST

Sphagnum angustifolium (Russow) C. Jens.: With small cranberry (*Vaccinium oxycoccos, 317,* BH, R.D.) on open central mat of Hungry Hill Bog, 16 Jun 1977 (*M-144,* R.D.).

Sphagnum centrale C. Jens.: Around the roots of turtlehead (*Chelone glabra, 144,* R.D.) in N moat of Hungry Hill Bog, 25 Aug 1976 (*M-271,* R.D.).

Sphagnum fimbriatum Wils.: On hummock in shade, N moat of Hungry Hill Bog, 11 Sep 1977 (*M-120,* BING, R.D.).

Sphagnum girgensohnii Russow: Fruiting, N moat of Hungry Hill Bog, 11 Sep 1977 (*M-121,* BH, BING, R.D.); in wooded mire on Jensen Hill, near Long Eddy, Sullivan County, New York, 21 May 1983 (*M-184,* BH, BING, R.D.); Bouchoux's Swamp, 15 Sep 1984 (*M-243,* BH, BING, R.D.).

Sphagnum henryense Warnst.: Under hemlocks (*Tsuga canadensis*), Bouchoux's Swamp, 17 Apr 1977, (*M-127,* BING, NYS, R.D.; *M-128,* BH, BING, R.D.).

Sphagnum imbricatum Russow: Marshy edge of large meadows, Rock Valley, ca. 1100 feet E of Biedenknapp Road, 23 Aug 1980 (*M-169,* BH, BING, R.D.). [=*S. affine* Ren. & Card.].

Sphagnum lescurii Sull.: Delaware Lake, ca. 2500 feet E of Hungry Hill Road, 11 Sep 1977 (*M-117, M-118,* both BING, R.D.).

Sphagnum molle Sull.: On hummock beneath hemlocks (intergrown with *Hypnum pratense, M-162,* BH, NYS, R.D.), Log Cabin Marsh, 16 Apr 1977 (*M-125,* BH, BING, R.D.).

Sphagnum nemoreum Scop.: Base of dead hemlock, W side of Log Cabin Marsh, 16 Apr 1977 (*M-124,* BH, BING, R.D.).

Sphagnum palustre L.: Wet road bank near Hancock Golf Course, Hancock (village), 27 Mar 1976 (*M-49,* BING, R.D.).

Sphagnum russowii Warnst.: On hummock beneath hemlock, E side of Bouchoux's Swamp, 17 Apr 1977 (*M-126,* BH, BING, R.D.).

Sphagnum squarrosum Crome: At base of dead hemlock, W side of Log Cabin Marsh, 16 Apr 1977 (*M-123,* BH, BING, R.D.); N-central, undisturbed part of Bouchoux's Swamp, 15 Sep 1984 (*M-244, M-246,* BH, BING, R.D.; *M-245,* BING, NYS, R.D.).

Sphagnum subtile (Russow) Warnst.: On hummock near spring, Log Cabin Marsh, 8 Nov 1975 (*M-24,* BING, R.D.).

Sphagnum teres (Schimp.) Ångstr.: On hummock beneath hemlock, Log Cabin Marsh, 8 Nov 1975 (*M-11,* BING, R.D.).

Sphagnum warnstorfii Russow: On hummock beneath hemlock, Bouchoux's Swamp, 17 Apr 1977 (*M-129,* BH, BING, R.D.).

DISCUSSION AND CONCLUSIONS

The town of Hancock is included in "Distributional District 19" of New York State, from which only seven Sphagnum species were previously reported (Ketchledge, 1980). The 15 species noted herein add nine new species, S. angustifolium, S. fimbriatum, S. henryense, S. molle, S. nemoreum, S. russowii, S. subtile, S. teres and S. warnstorfii. Except for S. molle, all the other species have been reported from nearby (Ketchledge, 1980; Andrus, 1980), and were to be expected. The occurrence of S. molle, however, is very unusual. Of it, Richard E. Andrus wrote (letter to R. Dirig, 13 Jan 1981): "S. molle, until now, was known only from strictly coastal bogs except for the Blue Ridge Mts. of North Carolina. It is fairly common on Long Island [New York] where it forms small mats & low hummocks over wet sand."

The negative impact of beaver activity on native wetland vegetation, including Sphagnum, is evident from my site descriptions. Since 1955, nearly every wetland in the Town of Hancock has at one time or another been flooded by beavers, and the effects are devastating and long-lasting. Beavers girdle, cut or drown large trees, deepen and channel waterways and trample plants growing nearby. Their activity alter shade and temperature regimes of habitats for decades afterwards, destroying stations for some of the rarest Catskill plants. One of two known Catskill populations of Goodyera tesselata (Bouchoux's Swamp) and the only station of Thelypteris simulata (Hungry Hill Bog) are gone because of the activities of this rodent. In Hancock Town, mires known as "Cranberry Marsh," "Elm Swamp" and the shores of Pierce Pond were flooded by beavers before it was possible to botanically explore them. Emmons Pond Bog, a 150-acre, Nature Conservancy-maintained perserve in Davenport Town, northern Delaware Co., New York, was flooded by beavers within a few years (Karl L. Brooks, pers. comm.). Since it was a preserve, with a policy of noninterference with any "natural" developments, the people involved would not prevent beaver damage to this splendid bog. In adjacent Wayne Co., Pennsylvania, Dix (1965) documented the flooding of a bog by beavers. Destruction of the Hungry Hill Bog is particularly unfortunate, as it was the only surviving mire of its type in the southern part of Delaware County.

Elimination of its natural predators, state regulation of trapping, and a reduced demand for furs have apparently allowed the beaver to increase to the point where it may move into any wetlands that can even marginally support it. Fragile mires cannot withstand this for more than a season or two; and when the animals move on, they leave a place devoid of many of its former botanical rarities. I believe that beaver penetration into even remote forest mires has greatly accelerated during the last 20 years in the southwestern Catskills. It is critical that the numbers of these mammals be reduced, if any wooded wetlands are to survive which approach their virgin state.

ACKNOWLEDGMENTS

Richard E. Andrus determined all Sphagnum specimens mentioned, coached on laboratory keying, and reviewed a draft of this paper. Permission to collect on private property was granted by Maretta Bouchoux, Raymond Bouchoux, Quintin Dirig, George Nevin, Ruth Nevin, Ed Rauch and T. D. Rango. Michael J. Birmingham and Sandra Meier of the New York State Department of Environmental Conservation issued me permits to collect plants in the New York State Forest Preserve. Kristin A. Barron, John F. Cryan, Matthew F. J. Dirig and John W. Hollister helped explore wetlands and collect Sphagnum in Hancock Town. John F. Cryan also reviewed a draft of this paper before publication.

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NOTES ON NEW AND RARE MOSSES IN SOUTHWESTERN COLORADO

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Weber (1973) drew together the literature on Colorado mosses and combined it with the results of his own work to issue the very useful, and preliminary, Guide to the Mosses of Colorado. He reported 292 species and varieties for the state. Since then, my own floristic field work in the little-studied southwestern corner of the state, particularly the San Juan Mountains, has added three mosses new to the flora, as well as collections which extend the range for eight other rare Colorado species. New state records are designated by an asterisk. The nomenclature used here follows Crum et al. (1973). Voucher specimens for each species are in the author's herbarium at Fort Lewis College. Duplicates of all specimens, except Racomitrium sudeticum, are deposited at COLO.

Andreaea rupestris Hedw. - San Juan Co.: San Juan Mtns., on the densely bryophyte-covered vertical face of a siliceous outcrop in a cool, spruce-shaded seasonal drainage along Hwy 550 just S of Coal Bank Pass, 37°41'15"N, 107°46'21"W, 3292 m, *Jamieson 8651*; San Juan Mtns., on dry siliceous outcrops in a spruce grove along Mountaineer Creek, 37°46'31"N, 107°35'18"W, 3505 m, *Jamieson 10046*. Weber's (1973) remark that *A. rupestris* is strictly alpine in Colorado must be extended to accommodate these specimens from shaded, streamside, siliceous outcrops in subalpine spruce groves. The species is widespread, but infrequent, in subalpine locations in the western San Juan Mountains.

Dicranella varia (Hedw.) Schimp. - La Plata Co.: Trimble Lane crossing of the Animas River, 37°10'N, 107°50'W, 2005 m, *Jamieson 10639*. Weber (1973) noted a willow thicket at 3048 m in Boulder Co. as the solitary Colorado station for this species. This second site occurs on soil in a cottonwood-shrub thicket along the bank of a side channel of the Animas River. The inconspicuous nature of this otherwise weedy species probably accounts for its apparent rarity. Additional populations should be expected in the area.

**Hygroamblystegium noterophilum* (Sull. & Lesq. *ex* Sull.) Warnst. - Archuleta Co.: San Juan Mtns., submerged on calcareous sandstone in Elk Creek, along the First Fork Rd. of the Peidra River, 37°16'22"N, 107°20'W, 2195 m, *Jamieson 10438*. Flowers (1973) reported this species as frequent in Utah. It is probably present elsewhere in Colorado, but overlooked.

**Hygrohypnum alpestre* (Hedw.) Loeske - San Juan Co.: San Juan Mtns., in a seepage on the N slope of Sugarloaf Mtn. above Mountaineer Creek, 37°46'35"N, 107°35'25"W, 3658 m, *Jamieson 10154*. This occurrence establishes an extraordinary arctic-alpine disjunction. The nearest Cordilleran location is approximately 3400 km N at Lake Lindeman, British Columbia, near the Yukon border (Jamieson, 1976). The Colorado site, a sunny seepage, supports 16 small, sterile patches adhering to exposures of Precambrian gneiss irrigated by shallow, but very cold water. It is noteworthy that Sugarloaf is one of numerous peaks in the vicinity that rose as nunatuks above the Animas Valley Glacier of Late Pleistocene time (Atwood & Mather, 1932). Thus it is possible that the population of this species represents a Pleistocene relict. The seepage is surrounded by tundra that is dissected by numerous willow-filled drainages and by gneissic outcrops. The occurrence here of *H. alpestre* coincides with that of *Huperzia selago* (L.) Bernh., which itself is rare in Colorado and confined to very high mountain sites.

Hygrohypnum cochlearifolium (Vent. *in* De Not.) Broth. - San Juan Co.: San Juan Mtns., in seepages on the steep N slope of Sugarloaf Mtn., 37°46'35"N, 107°35'15"W, 3597 m, *Jamieson 10361, 10362, 10375, 10376, 10377, 10379* c.fr. This stunning find is remarkable for several reasons. Like *H. alpestre*, its occurrence in Colorado documents another arctic-alpine distribution in western North America. Numerous patches of *H. cochlearifolium* grew in small to large seepages on the shaded N sides of intermittently exposed vertical outcrops of Precambrian gneiss. The outcrops emerge on the steep N-facing tundra-covered slope of Sugarloaf Mtn. Especially surprising was the discovery of several patches bearing sporophytes, all but two of which were left undisturbed. This occurrence confirms four earlier, unpublished collections of the species in the Rocky Mtns. Rydberg collected the species at Electric Peak, Montana in 1897 (NY). Three specimens at COLO document a scattered presence for the species in the Front Range of the Colorado Rockies. In 1963 Vaarama discovered it on Mt. Evans in Clear Creek Co. (Jamieson, 1976); Hermann (*27476*) located a second Clear Creek Co. station at Naylor Lake and Weber et al. (*B-57026*) discovered a population in Boulder Co. at "Haplomitrium Hill" in Green Lakes Valley.

Hygrohypnum smithii (Sw. *in* Lilj.) Broth. - San Juan Co.: San Juan Mtns., on irrigated rocks in a deeply shaded seasonal stream along Hwy 550 just S of Coal Bank Pass, 37°41'15"N, 107°47'05"W, 3109 m, *Jamieson 7913*. Jamieson (1976) established a Colorado presence for *H. smithii* based on a F. J. Hermann collection (*26660*, COLO) from the N Fork of Middle Boulder Creek along the Diamond Lake Trail in Boulder Co. Later Hermann made a second collection (*26738*, COLO) in Jackson Co., from an unnamed stream crossing the Lone Pine Creek Trail in the Mt. Zirkel Wilderness. The San Juan Co. collections reported here enrich the species' rather scattered distribution within the state. The Colorado distribution of *H. smithii*, which must surely be at or very near its southern range limit, suggests that the species might be expected to occur rather more commonly, though undiscovered, in the central Rockies of Wyoming and southern Montana.

Racomitrium canescens (Hedw.) Brid. - San Juan Co.: Little Molas Lake, 37°44'30"N, 107°42'30"W, 3322 m, *Jamieson 8677, 9561, 9563*; El Dorado Lake, 37°42'47"N, 107°32'W, 3840 m, *Jamieson 9694, 9699, 9701, 9706*; Spencer Basin, 37°46'30"N, 107°35'34"W, 3688 m, *Jamieson 10132, 10136*; Mountaineer Creek, 37°46'30"N, 107°35'19"W, 3505 m, *Jamieson 10236*; Lime Creek, 37°38'10"N, 107°45'W, *Jamieson 10339*. Weber (1973) remarked that *R. canescens* was rare in Colorado as evidenced by only three specimens from alpine tundra. Recently, Weber (pers. comm.) reported that *R. canescens* has been found in widely distributed sites in the Front Range area west of Boulder and further west in Grand Co. The San Juan Co. collections are reported here to document a well-established presence for the species in diverse San Juan Mtn. habitats. At El Dorado Lake individual stems and small patches were found as described by Weber as "occurring inconspicuously in alpine tundra." In contrast, at Spencer Basin two large specimens were taken from nearly pure mats on flat gneissic boulders. In a subalpine spruce grove along Mountaineer Creek, *R. canescens* was found on a very dry rock outcrop, but at Little Molas Lake, another subalpine station, the plant occurred in well-developed patches on sunny soil under and around spruce groves. The species is quite common at Little Molas Lake. The most robust material came from Lime Creek

Canyon. This single collection was taken from a large, bright-green mat on soil in an opening in a dense streamside spruce-aspen forest. Determination of these specimens with Frisvoll's (1983) treatment reveals that they are all *R. canescens* subsp. *canescens*, although the papillae in the upper part of the leaves are sometimes not as large as illustrated by Frisvoll. No specimen had sporophytes, although perichaetia were found on all but the smallest stems.

Racomitrium sudeticum (Funck) B.S.G. - San Juan Co.: San Juan Mtns., El Dorado Lake, 37°42'47"N, 107°32'W, 3840 m, *Jamieson 9714*. Weber (1973) reported a solitary Colorado record from Mt. Achonee. Weber (pers. comm.) reports that the species is now known to occur at several other sites in the Rockies of northern Colorado. The San Juan Co. specimen documents a wider distribution for the species in the state. The small, sterile plant was taken from a gneissic outcrop.

**Seligeria campylopoda* Kindb. *ex* Macoun & Kindb. - Archuleta Co.: Elk Creek drainage along the First Fork Rd. of the Piedra River, 37°16'22"N, 107° 20'W, 2195 m, 21 Aug 1983, *Jamieson s.n.* La Plata Co.: along the Junction Creek Rd. on the S side of Barnes Mtn., 37°21'39"N, 107°53'48"W, 2646 m, *Jamieson 9506, 9507*. Flowers (1973) included *S. campylopoda* in the Utah bryoflora, citing its presence at a location in the Wasatch Mtns. However, Vitt (1976) was unable to study the Utah specimens and reported the presence of *S. campylopoda* in the Cordillera only as far S as southern Montana. Vitt (pers. comm.) has verified that my Colorado specimens are indeed *S. campylopoda*. Flowers provided an accurate description and an illustration that is clearly referable to *S. campylopoda*. Thus, the new Colorado collections and the Utah material confirm a long Cordilleran range extension for the species. The very small Archuleta Co. collection was taken from a small calcareous sandstone rock under dense forest shade along Elk Creek. The La Plata Co. collections came from a massive population growing on aspen-shaded calcareous sandstone outcrops along a seasonal stream.

Tayloria acuminata Hornsch. - San Juan Co.: Cascade Creek Gorge, 37°39'12"N, 107°46'20"W, 2621 m, *Jamieson 8130*. Weber (1973) stated that in Colorado the species was known from only two old collections "from within 100 miles of Canyon City." The present collection was found mixed with *Pohlia* and *Tortula* on what appeared to have been bird dropping on soil. The site was at the top of the gorge on the S side of the creek. The specimen bears several well-developed capsules, which exhibit the characteristic 32 peristome divisions. The leaves are acuminate with bluntly serrate margins.

Tortula brevipes (Lesq.) Broth. - Montrose Co.: Paradox Valley, pinon-juniper slope beside the Dolores River, 38°18'32"N, 108°53'07"W, 1525 m, *Jamieson 10646, 10647*. Weber (1973) reported that in spite of Steere's (1939) inclusion of the species in the state and Geneva Sayre's possession of a Colorado specimen, he had not seen a definite record of the species for Colorado. The present specimens were taken from calcareous soils and sandstones underlying a pinon-juniper forest beside the Dolores River very near the river's crossing of State Hwy 90. The awns are clearly smooth, the basement membranes account for half of the peristome length, and some of the capsule urns reach 4 or 5 mm in length. However, all the leaf apices are acute or acuminate, a feature which Flowers (1973) noted was present but not common in Utah collections. Various authors (Steere, 1939; Lawton, 1971; Flowers, 1973) suggested the disposition of sex organs in the species is variable or uncertain. They agree that *T. brevipes* is dioicous, monoicous or autoicous. In any event, the Colorado collections are clearly paroicous.

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TWO COLLECTIONS FROM CALAVERAS COUNTY YIELD TWO MOSSES NEW TO CALIFORNIA

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The author's collection of June 5, 1981, made at the old copper digs at Copperopolis included *Scopelophila cataractae* (Mitt.) Broth. (*Steen 810605-2*), found growing in seepage in a concrete culvert. No further sites were located. The area is an open lower oak woodland with *Quercus douglasii* and *Pinus sabiniana*. This moss has been reported from the Santa Rita and Patagonia Mountains of southern Arizona in collections of E. B. Bartram (Zander, 1967). It does not appear in the lists of Harthill (1979) or Norris (unpubl.).

A second collection of March 26, 1984, gave capsule-bearing plants of *Physcomitrium collenchymatum* Gier growing on moist soil above Camanche Reservoir near Burson (*Steen 840326-8*). The author knows of no other report of this species farther west than Kansas (Crum & Anderson, 1981). Since the area is frequented by campers, it may well have been introduced by them.

Vouchers for both specimens are deposited at CINC and DUKE.

I should like to thank J. A. Snider and H. Crum for their kind determinations of the *Physcomitrium* material. Thanks are due also to B. and K. Kowalewsky who provided transportation. This work benefited from support of Contract DE-AC03-76-SF00012 between the University of California and the U. S. Department of Energy.

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TEN MOSSES NEW TO WISCONSIN

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Recent field collecting and reexamination of older herbarium material has identified ten moss taxa, including one genus, Racomitrium, new to the state of Wisconsin, based on Bowers & Freckman (1979). Nomenclature follows Andrus (1980a, 1980b) and Crum & Anderson (1981).

Anomodon rugelii (C. Müll.) Keissl. - Shawano Co.: 8.9 km E of Wittenberg, T.27N., R.12E, S.16, *Bowers 9730* (UWSP, MIL). Nearest reported populations: Illinois (Redfearn, 1972; McCleary and Redfearn, 1979; Crum & Anderson, 1981), Michigan (Darlington, 1964; Crum & Anderson, 1981; Crum, 1983), Ontario (Crum & Anderson, 1981; Crum, 1983).

Encalypta rhaptocarpa Schwaegr. - Columbia Co.: Richmond Memorial County Park, Gibraltar Rock Natural Area, 2.4 km SW of Okee, T.10N, R.8E, S.18, *Christy 4160* (MIL). Nearest reported populations: Michigan (Darlington, 1964; Crum & Anderson, 1981; Horton, 1983; Crum, 1983), Minnesota (Churchill, 1976), Ontario (Crum & Anderson, 1981; Horton, 1983), South Dakota (Crum, 1983).

Funaria flavicans Michx. - Kenosha Co.: Chiwaukee Prairie Natural Area, 8 km SSE of Kenosha, T.1N, R.23E, S. 31 & 32, *Christy 3750* (MIL). Nearest reported populations: Illinois (Redfearn, 1972; McCleary & Redfearn, 1979; Crum & Anderson, 1981), Indiana (Welch, 1957), Iowa (Peck, 1978), Missouri (Churchill, 1976), Ontario (Crum & Anderson, 1981; Crum, 1983).

Racomitrium heterostichum (Hedw.) Brid. - Forest Co.: Nicolet National Forest, Scott Lake-Shelp Lake Natural Area, 12 km ESE of Three Lakes, T.38N, R.12E, S.17, *Christy 4779* (MIL). Nearest reported populations: Michigan (Darlington, 1964; Crum & Anderson, 1981; Crum, 1983), Minnesota (Crum & Anderson, 1981), Ontario (Crum, 1983).

Sphagnum andersonianum Andrus - Polk Co.: Tula Lake Natural Area, 12 km ESE of Frederic, T.36N, R.16W, S.2, *Christy 4543* (MIL). Nearest reported populations: New York (Andrus, 1980b).

Sphagnum flexuosum Dozy & Molk. - Dane Co.: Oregon, *Hermann 28334* (WIS). Douglas Co.: 1.6 km N of Gordon, T.44N, R.12E, S.36, *Koch 5437* (WIS). Nearest reported populations: Minnesota (Andrus, 1980b).

Sphagnum henryense Warnst. - Jefferson Co.: Hope Lake Bog, 3.2 km E of Cambridge, T.7N, R.13E, S.32, 17 Apr 1934, *Sieker s.n.* (WIS). Nearest reported populations: Illinois, Indiana, Michigan (Andrus, 1980b, 1980c).

Sphagnum recurvum P.-Beauv. s.s. - Forest Co.: *Newberry 66163* (WIS). Nearest reported populations: Illinois, Indiana, Missouri (Andrus, 1980b).

Sphagnum subfulvum Sjörs - Ozaukee Co.: Cedarburg Bog Natural Area, 5.6 km NW of Saukville, T.11N, R.21E, S.29, *Christy 4694* (MIL). Nearest reported populations: Michigan (Andrus, 1980b; Crum, 1976, 1984), Minnesota (Andrus, 1980b), Ontario (Crum, 1984).

Tortella inclinata (R. Hedw.) Limpr. - Green Co.: Muralt Bluff Prairie Natural Area, 4.8 km WSW of Albany, T.3N, R.8E, S.25, *Christy 4179* (MIL). Nearest reported populations: Michigan (Darlington, 1964; Crum & Anderson, 1981; Crum, 1983), Ontario (Crum & Anderson, 1981; Crum, 1983).

This work was supported in part by grant G008103820 from the Institute of Museum Services, awarded to the Milwaukee Public Museum's Botany Section, M. J. Dibben as principal investigator. We are grateful for the assistance of the Wisconsin DNR Natural Areas Preservation Council, Nicolet National Forest, The Nature Conservancy, the University of Wisconsin-Parkside and the curators at WIS.

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Single copies of Steven P. Churchill's "A synopsis of the Kansas mosses with keys and distribution maps" (Univ. Kansas Sci. Bull. 53: 1-64. 1985) may be obtained free from the author at the New York Botanical Garden, Bronx, NY 10458-5126, U.S.A.

PROCESSING LICHEN COLONIES GROWING ON SOIL OR MOSS, WITH GLUE TO FACILITATE SECTIONING

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Various treatments have been used for binding soil or moss on which lichens are growing. Gates (1958) recommended "Rhoplex AC-33" acrylic resin emulsion. Nearing (1947) recommended a 10:1 mixture of water to white glue, and Nash (unpubl.) has suggested a 2:1 mixture. Other lichenologists have also used dilute solutions of white glue for this purpose. However, these workers apparently have not used the soil-binding substance specifically for sectioning either the lichen or the substrate.

Several different methods have previously been used for making thin sections of lichens. Freezing microtomes of various types have been used in different studies, including studies of primarily terricolous lichens (e.g., Schneider, 1979). A method using alginate and carbowax for making serial sections with a rotary microtome or a freezing microtome was described by Christiansen (1975), who discussed the advantages and disadvantages of that method compared with older methods that used paraffin.

Our interest in techniques for processing and sectioning terricolous or muscicolous lichens came from our investigations into the anatomy and biology of certain taxa (to be reported on at a later date, along with photographs of sectioned specimens). We desired not only to bind the substrate for preservation of the specimen, but also to make both thin and thick sections through both the lichen and its substrate.

A very effective technique for sectioning lichens on soil or moss, using diluted white glue, was developed in the 1960's by Vic G. Duran, a photographer and amateur lichenologist who headed the Scientific Photography Laboratory at the University of California in Berkeley for many years. Mr. Duran had received graduate training in botany and was always a careful worker and scholar. Incidentally, lichenologists might also be familiar with him because he was the father of Sylvia Duran Sharnoff, whose exhibits of fine colored photographs of lichens are currently being shown in various museums in the United States and Canada. Unfortunately, Duran did not publish his glue technique. We now present a method, based on Duran's, for processing lichen colonies with glue for sectioning. Although Duran mainly used the glue technique for thallus sectioning rather than thallus-plus-substrate, with minor modifications his technique can be adapted for various uses, as described below.

The glue must be readily soluble in water, so that when adequately diluted with water it will permeate a soil or moss substrate in a short time, and so that it can easily be dissolved out later if desired. Duran originally used "Elmer's School Glue," but several other types, including "Elmer's Craft Bond" and "Elmer's White Glue" (or their equivalents) are also effective. The optimum ratio of water to glue depends on the consistency of the substrate and the purpose of the preparation. For fine, compact soil, a 5:1 ratio usually prevents the soil from crumbling yet is fairly easy to cut. For a coarse substrate with numerous air spaces, the dilution often needs to be decreased to 2:1 for sectioning.

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[1] Unfortunately Dr. McWhorter passed away in November, 1985. As he provided the initial stimulus for this article and prepared the first draft, which I revised to its present form, I have listed him as a co-author.

For consistent results, the bottom surface of the substrate needs to be cut (if possible) such that the specimens sit flat and are all roughly the same thickness, prior to soaking in glue. Loose dust can be removed by shaking the specimens gently in a wire mesh container or by blowing with compressed air.

Sufficient glue solution should be placed in the container (petri dish or tray) to permit immersion of the lower third of the specimen (substrate only). An immersion of about one minute is usually sufficient, but longer immersion can be used to increase the firmness or hardness of the specimen. Treated specimens can be cut when still slightly moist, but slicing dry specimens usually gives the smoothest surfaces. The specimens can be dried by placing them lichen-side down on a ceramic or plastic surface (never on paper or cardboard). After partial drying, they can be turned right side up to avoid sticking the lichen to the container.

After drying, the specimen can be glued to a card or be sectioned. Gluing the specimen to a card and then sectioning after the glue dries may be desirable, especially with small or thin specimens.

For examination of thick vertical sections under a dissecting microscope, the specimens can simply be cut with a razor blade. If the treated specimen is hard enough, fairly thin sections (at least of the lichen) can be "shaved" off and examined under a compound microscope. For examining the relationship of the lichen to its substrate, "underground" features of interest (e.g., attachment organs) can be detected in thick sections and then teased out, so that they can be examined in squash mounts or after other processing and then sectioning with a microtome.

Different types of glue may have their own advantages and disadvantages. The "School Glue" originally used by Duran has such a formulation that it acts like an embedding agent, and if used in sufficient quantity forms a coating around the specimen. Cutting must be done before the coating gets too hard. Glue may also produce artifacts, such as sheets or strands on the surface or microscopic particles obscuring the true nature of the specimen. It may interfere with chemical analyses (e.g., "Elmer's School Glue" turns pink in iodine solution, makes spotting thin layer chromatography plates difficult, and produces a dark spot at the origin on the TLC plate after spraying with H_2SO_4). However, the "School Glue" is easily dissolved out by soaking the specimen in water. The "Craft Bond" glue may be better in that specimens treated with it can still be easily sectioned days or even months after treatment.

In general, the glue technique offers a number of advantages, and it is versatile enough to be adapted for various purposes. Treatment with diluted glue can be used simply for preserving fragile lichen colonies for herbaria, or for rapid, easy, inexpensive preparation of numerous sections in broad surveys. (It can easily be used by amateurs without special supplies or equipment.) It can be used for making thick or fairly thin sections, and it can be used preparatory to thin-sectioning by mechanical means. Because of abundant sand in many substrates, direct machine sectioning of whole colonies of lichens on soil or moss is often not feasible. Most colonies are too fragile to be hand-sectioned without some kind of pre-treatment. A water-soluble glue supports the specimen while it is being cut, but the glue can be dissolved away, leaving no foreign material that might interfere with observing (or chemically analyzing) the specimen. This is an advantage over techniques that use non-water-soluble embedding materials. An obvious advantage of the glue technique over freezing is that the cutting does not have to be done immediately; instead, glue-treated specimens cut nicely a long time after treatment (at least with some kinds of glue).

Further experimentation with various modifications of the glue treatment undoubtedly will suggest new possibilities and perhaps improvements. The glue technique may also have applications in the study of other organisms (e.g., bryophytes) growing on soil. The authors hope that this preliminary report will stimulate feedback and exchange of information.

The authors wish to express their gratitude to Sylvia Duran Sharnoff for her helpful comments regarding our article based on the technique developed by her father, Vic Duran.

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NOTICE

D. J. Borror. 1960. Dictionary of word roots and combining forms. 134 pp. Price: $5.95 (paper). [Available from: Mayfield Publishing Company, 285 Hamilton Avenue, Palo Alto, CA 94301].

This compilation of Latin and Greek word roots has been available for more than 25 years but may be unfamiliar to many of our younger readers. More than 10,000 word roots and combining forms are included, as well as rules for the coining and pronunciation of scientific names. For the price, a quick and useful reference of this nature is difficult to ignore.--R. A. Pursell.

MOSSES AND LIVERWORTS OF SOUTHEASTERN ALASKA

This intensive field course in bryology will take place in the Juneau area of southeastern Alaska and will include: ecology, taxonomy, structure, collecting & herbarium techniques, field identification and fossil mosses in peat. It will be taught August 11-22, 1986 by Dr. Joannes A. Janssens. Credit is available from the University of Alaska-Juneau and the University of Colorado-Boulder. Write or call concerning tuition, credit and accommodation to: Mountain Research Station, Institute of Arctic and Alpine Research, University of Colorado, Nederland, CO 80466; (303)492-8841.

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SOME SPHAGNA FROM GREAT WASS ISLAND, MAINE

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The *Sphagnum* flora of the state of Maine is poorly known. The only available checklist is Andrews' dating back to 1906 in which 43 taxa are listed. With updated generally accepted taxonomic concepts, this number could be reduced to something like 31 taxa. In this paper, 21 species all previously reported from Maine are reported to occur on Great Wass Island.

Great Wass Island (44°30'N - 67°35'W) is located along the coast in Washington County, Maine, off the Town of Jonesport. The island is 3.5 miles long, approximately 3000 acres in size, and composed of granitic bedrock. A cool, moist maritime climate prevails in the area. The Nature Conservancy, a non-profit conservation organization, owns 1500 acres at the southern end of the island where this study was conducted.

There are several large peatlands "bogs" at the southern end of Great Wass Island. Damman (1977) and Worley (1982) have described these coastal raised peatlands which are unusual because jack pine (*Pinus banksiana*) grows on the peatland.

The southern portion of the island was crossed on August 17, 1975 (collecting numbers 5530 to 5553) and on August 14, 1976 (collecting numbers 5627A to 5638) in company with Dr. Charles D. Richards, former professor of the University of Maine at Orono. The purpose of the study was only to get an idea of which *Sphagnum* species are growing on this part of the island. The nomenclature of vascular plants follows Fernald (1950). *Sphagnum* nomenclature follows Isoviita's 1966 treatment.

Sectio Sphagnum

Sphagnum imbricatum Russ. (1) Very open jack pine bog forest with a *Kalmia angustifolia* shrub layer and *Empetrum nigrum* spreading on a *Sphagnum* moss carpet dominated by *Sphagnum fuscum* forming hummocks (5531). (2) At edge of bog, dense thicket of *Nemopanthus mucronata* with a few scattered jack pines and a dense shrub layer made of *Gaylussacia baccata*, *Kalmia angustifolia* and *Myrica gale* (5535 mixed with *S. magellanicum*).

Sphagnum magellanicum Brid. (1) Wet depression in a *Carex exilis* - *Scirpus cespitosus* var. *callosus* - *Gaylussacia dumosa* var. *bigeloviana* - *Sphagnum fuscum* - *Sphagnum flavicomans* bog community (5538). (2) Black spruce - red maple open forest along a brook with a dense thicket of *Nemopanthus mucronata*, *Myrica gale*, *Viburnum cassinoides* and an understory of *Kalmia angustifolia* with a *Sphagnum* covered ground (5544). (3) At edge of bog, dense thicket of *Nemopanthus mucronata* with a few scattered jack pines and a dense shrub layer made of *Gaylussacia baccata*, *Kalmia angustifolia* and *Myrica gale* (5533 mixed with *S. imbricatum*).

Sphagnum palustre L. (1) Black spruce open forest with *Calamagrostis canadensis*, *Aster nemoralis*, *Iris versicolor* and *Lycopus uniflorus* herb layer scattered with clumps of *Myrica gale* (5546). (2) Black spruce - white birch forest with *Carex trisperma* and *Sphagna* (5550).

Sphagnum papillosum Lindb. (1) Cedar swamp with ground covered with *Sphagnum* colonies and *Carex trisperma* (5631).

Sectio Rigida

Sphagnum compactum DC. (1) Black spruce-jack pine open forest on shallow glacial till with *Kalmia angustifolia* shrub layer and *Cladonia* ground covered (5548).

Sectio Subsecunda

Sphagnum subsecundum Nees (1) Just above the high tideline, depression with *Juncus* sp. with water table above the surface. Plant more or less floating (5634)

Sphagnum pylaesii Brid. (1) Drying out wet depression in a jack pine forest with diffuse *Gaylussacia baccata*, *Kalmia angustifolia* shrub layer and lichens (mostly *Cladonia*) covered ground on shallow loose material derived from desintagrating bedrock of granitic rock (5522). (2) Along the shore, wet depression covered with *Sphagnum pylaesii* and scattered *Triglochin maritima*; the *Sphagnum* carpet broken up by low mounds colonised with *Poa* sp. and *Vaccinium macrocarpon* (5633).
Previously known in Maine only from Mount Desert Island (Crum, 1984).

Sectio Cuspidata

Sphagnum cuspidatum Hoffm. (1) In a very wet depression with *Drosera intermedia* in a *Carex exilis* - *Rhynchospora alba* - *Sphagnum pulchrum* wet bog community (5541). (2) Floating into shallow water in a ditch by the gravel road (5638).

Sphagnum fallax (Klinggr.) Klinggr. emend Isov. (1) Black spruce-white birch forest with *Carex trisperma* and *Sphagna* (5551).

Sphagnum majus (Russ.) C. Jens. (1) In a jack pine forest; a very wet depression of small size with *Rhynchospora alba*, *Drosera rotundifolia*, *Eriophorum angustifolium* and *Sphagnum* spp. (5628).

Sphagnum pulchrum (Braithw.) Warnst. (1) Wet depression in a *Carex exilis* - *Scirpus cespitosus* var. *callosus* - *Gaylussacia dumosa* var. *bigeloviana* - *Sphagnum fuscum* - *Sphagnum flavicomans* bog community (5536).

Sphagnum tenellum (Brid.) Brid. (1) Along a path in a very open jack pine bog forest with a *Kalmia angustifolia* shrub layer and *Empetrum nignum* spreading on a *Sphagnum* moss carpet dominated by *Sphagnum fuscum* forming hummocks (5534). (2) Wet depression in a *Carex exilis* - *Scirpus cespitosus* var. *callosus* - *Gaylussacia dumosa* var. *bigeloviana* - *Sphagnum fuscum* - *Sphagnum flavicomans* bog community (5537). (3) Open jack pine forest on granitic rock with *Kalmia angustifolia* and *Cladonia* spp. (5627B).

Sectio Polyclada

Sphagnum wulfianum Girg. (1) Balsam fir - white birch forest with mountain ash and red spruce (5553).

Sectio Acutifolia

Sphagnum angermanicum Melin emend Maass (1) Black spruce - red maple open forest along a brook with a dense thicket of *Nemopanthus mucronata*, *Myrica gale*, *Viburnum cassinoides* and an understory of *Kalmia angustifolia* with a *Sphagnum* covered ground (5543).
Reported to be rather common on Mount Desert Island by Maass (1967) being the only previously known locality in Maine. Recently reported from New Hampshire (Holcombe, 1979). Known also from New York and New Jersey. A rather rare plant in New England. Our specimen bears sporophytes.

Sphagnum fimbriatum Wils. (1) Black spruce open forest with *Calamagrostis canadensis*, *Aster nemoralis*, *Iris versicolor* and *Lycopus uniflorus* herb layer scattered with clumps of *Myrica gale* (5545). (2) Along the shore, disturbed area with *Agrostis scabra*, *Hypericum virginicum* and *Ribes glandulosum* (5635). (3) On granitic rocks along the shore in a *Vaccinium macrocarpon* - *Aster nemoralis* - *Drosera rotundifolia* community (5637).

Sphagnum flavicomans (Card.) Warnst. (1) Very open jack pine bog forest with a *Kalmia angustifolia* shrub layer and *Empetrum nigrum* spreading on a *Sphagnum* moss carpet dominated by *Sphagnum fuscum* forming hummocks (5532). (2) In a *Carex exilis* - *Rhynchospora alba* - *Sphagnum pulchrum* wet bog community (5540). (3) Black spruce - red maple open forest along a brook with a dense thicket of *Nemopanthus mucronata*, *Myrica gale*, *Viburnum cassinoides* and an understory of *Kalmia angustifolia* with a *Sphagnum* covered ground (5542). (4) Open black spruce-red maple swamp with *Nemopanthus mucronata* and *Myrica gale*. Plant forming large high hummocks (5630).

Previously known in Maine only from Mount Desert Island (Crum, 1974).

Sphagnum fuscum (Schimp.) Klinggr. (1) Very open jack pine bog forest with a *Kalmia angustifolia* shrub layer and *Empetrum nigrum* spreading on a *Sphagnum* moss carpet dominated by *Sphagnum fuscum* forming hummocks (5530).

Sphagnum girgensohnii Russ. (1) Black spruce - white birch forest with *Carex trisperma* and *Sphagna* (5549).

Sphagnum nemoreum Scop. (1) Along the shore, black spruce-red spruce-white birch forest with *Kalmia angustifolia* shrub layer (5547). (2) Wet depression with *Carex canescens* and *Sphagnum recurvum s.l.* (5672A). (3) Cedar swamp with ground covered with *Sphagnum* colonies and *Carex trisperma* (5632).

Sphagnum rubellum Wils. (1) Along a path in a very open jack pine bog forest with a *Kalmia angustifolia* shrub layer and *Empetrum nigrum* spreading on a *Sphagnum* moss carpet dominated by *Sphagnum fuscum* forming hummocks (5533).

Sphagnum warnstorfii Russ. (1) In a *Carex exilis* - *Rhynchospora alba* - *Sphagnum pulchrum* - *Gaylussacia dumosa* var. *bigeloviana* - *Myrica gale* wet bog community (5539).

The humid climate of Great Wass Island combined with a good diversity of habitats has resulted in a rather rich *Sphagnum* flora. Nearly all the terrestrial coastal species possibly occuring on the island have been collected. One rare species namely *Sphagnum angermanicum* has been recorded. A search throughout the whole island would have provided us with more than the 21 species listed above. For example, *Sphagnum russowii* and *Sphagnum squarrosum*, two very common species, are surely occuring on the island but were not met with.

The author is much indebted to Dr. Charles D. Richard for his warm hospitality at his summer camp on Great Wass Island during field excursions, and to Dr. Harry R. Tyler Jr. for his criticism of the manuscript.

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LICHENOLOGICAL LITERATURE

The Farlow Library has received a considerable number of books and reprints from Dr. Carroll W. Dodge, prominent American lichenologist.

We now have a list of publications available for distribution or sale. If you'd like to receive a copy of the list, please send us a card with your name and address, marked: DODGE--LICHEN PUBLICATIONS.

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COMMON GARDEN CULTIVATION OF SPHAGNUM GAMETOPHYTES

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There have only been a few quantitative studies of Sphagnum that have used experimental taxonomic methods. All have used a modification of the common garden method by transplanting intact samples of gametophytes to a greenhouse environment and have used reciprocal transplants in the field. Agnew (1958) used various cultivation experiments to examine variation in several closely related species in section Cuspidata. She was only partially successful since she had difficulty in maintaining the plants in common culture for long periods of time and was not very successful with her reciprocal transplants in the field. Rahman (1972) used the same techniques to examine variation in several closely related species in section Subsecunda. Like Agnew, he was only partially successful in maintaining common garden cultures and reciprocal transplants in the field. Rahman's investigations are of limited value since some of the reciprocal transplants and common garden cultivation cultures were maintained for as few as two months, which has been considered to be too short to yield meaningul results (Andrus, 1974). Lane (1981) examined character variation of several species pairs from sections Sphagnum, Cuspidata and Subsecunda. He too was plagued with some problems in maintaining reciprocal transplants and common garden cultures for long periods of time. However, he was able to maintain some of the experiments long enough to demonstrate that such methods are valuable in solving taxonomic problems. The reason for most failures in common garden experiments with Sphagnum results in the failure to maintain the capillary system of the original site. Fungal contamination, resulting in the death of plants, is also common.

During the course of biosystematic studies of S. capillifolium sensu lato, I developed an inexpensive, easy to set up and maintain, and reliable method for maintaining Sphagnum gametophytes in common culture. The method permits easy manipulation of individual samples and may easily be modified for a wide range of experimental studies. I have also found that plants grown in the set-up that I will describe yield darker staining bands in protein electrophoresis than those examined immediately from the field.

Plants may be collected during any time of the year. However, I have found that plants collected after a period of extended drought are less likely to survive than those collected during the spring and early summer. I use samples consisting of about 30-40 plants or approximately one handful. Plastic sandwich bags are ideal for keeping samples moist and separate. I usually mark the plastic bags with a waterproof marking pen for identification and include a slip of paper inside the bag as a measure of extra security. It is important to maintain the original closely packed structure of nonaquatic species. If the samples cannot be transplanted immediately, they should be placed under refrigeration (above freezing). I have stored samples for periods as long as two weeks and successfully transplanted them. Most samples may be considered clonal in origin since many species reproduce vegetatively by extensive branching (Lane, 1977).

I originally wrapped each collection with fine nylon netting and packed the samples closely together in porcelin trays. This allows the samples to be packed closely together and yet remain separate (McQueen, 1985). However, I found that the plants grow considerably during the course of long term experiments (I believe that 10-12 months are adequate for most common garden experiments). The plants become loosely packed, which results in a breakdown of the capillary system and require frequent misting to prevent drying out. This can be a problem since I have recorded the growth for some species, from section Cuspidata, as over 20 cm in length during the course of a year.

I now pack individual samples into styrofoam cups. The cups are inexpensive, easily marked with a waterproof pen, and easy to manipulate. To accommodate growth beyond the top of the cup, I pull out the sample and cut off enough of the older portion of the plants so that the sample will fit back into the cup. Styrofoam cups also have the advantage that the water level of individual samples is easy to maintain. The water level has a profound effect on the growth and development of the plants. Submerged plants have very few fascicles of branches and are largely isophyllous (the stem leaves are identical to the branch leaves). This may be desirable for some experiments, but for taxonomic purposes anisophyllous plants are more desirable (the stem leaves are different in morphology from the branch leaves). Andrus (1980) provides an excellent discussion of morphological variation in Sphagnum. For species in section Acutifolia I keep the water level at 2 cm below the tops of the plants.

The samples in the cups are placed on a bed of commercial peat inside a tent made of chicken wire or other fencing material covered with heavy, white, polyethylene plastic. To construct the tents I first place a sheet of heavy plastic on the greenhouse bed. This is then covered with a layer of commercial peat. The tents are made in a hangar-like fashion. I use enough fence so that they measure about 75 cm high. Two boards are placed on the bed of commercial peat on opposite sides of the bench to hold the fence in place and help it maintain its shape. The frame of the tent is then covered with heavy, white, polyethylene plastic. I use one large sheet to cover the "roof" of the tent, fastening it down with duck tape to the fence. I use separate sheets to make "doors" at either end of the tent for easy access to the inside. The doors must be large enough to seal the tent to limit evaporation. I accomplish this by having them wrap around the outside walls of the tent. Before placing samples in the tent, moisten the peat by spraying it with a mist of water.

The tents are easy to maintain. I keep the plants moist by misting them twice a week with the same solution I use to maintain the constant water levels. The bed of peat should be kept moist. During summer months the doors of the tent may have to be partially opened to prevent overheating of the plants. The samples usually require some trimming every few months to keep them below the top of the cups. If samples grow beyond the top of the cups, they require more frequent misting. I have successfully maintained species from the sections Sphagnum, Acutifolia and Cuspidata for more than two years in some tents. I have also been able to induce some species to produce sporophytes using this set-up. The pH of the samples should be monitored because I have found that samples growing in solutions of a pH greater than 6.0 are more prone to become infected with fungi.

It is my hope that my success in using this common garden set-up will encourage further biosystematic studies of Sphagnum.

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Rahman, S. M. A. 1972. Taxomomic investigations on some British Sphagna. I. *Sphagnum subsecundum* sensu lato. Jour. Bryol. 7: 169-179.

SELIGERIA CAMPYLOPODA NEW TO WYOMING

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While processing bryophyte material recently collected in Wyoming preparatory to developing a county-level checklist for that state, I discovered a collection of tiny, fruiting plants, which upon verification proved to be *Seligeria campylopoda*.

Seligeria campylopoda Kindb. *in* Macoun & Kindb. USA, Wyoming, Sublette Co.: Teton National Forest, 5.3 mi N of Bondurant on US 191 and 189, Hoback River Valley, N-facing slope, rich, moist valley woodland, spruces, abundant herbage and bryophytes, on moist, shaded sandstone boulders, 5 Jul 1985, *Eckel 1121885* (ALTA, RM).

The sandstone may have had a calcareous matrix since this species of *Seligeria* is noted for its occurrence on limey substrates (Crum & Anderson, 1981). Vitt (1976) listed geographic localities of this species in North America with a concentration in the Pacific Northwest region of the United States and Canada. From there, stations are scattered across the northern United States to sites in eastern Newfoundland. Flowers (1973) mentioned a single collection from Utah (at 2700 m), and perhaps more western collections may be anticipaged from elevations at which mesic conditions prevail (the range portions of the Basin and Range physiographic province).

The Hoback River valley is an area of relatively high species richness, and this diversity is accessible from the road for anyone who would collect bryophytes in Wyoming. It forms a welcome contrast to the extended steppe country surrounding the highways in the southwestern portion of the state, with its *Atriplex* and composite-shrubs and pottiaceous mosses.

I thank Dale Vitt for kindly verifying the identity of this specimen.

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Flowers, S. 1973. Mosses: Utah and the West. Brigham Young University Press.
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DO ALL LIVERWORT ELATERS HAVE LEFT-HANDED SPIRALS?

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Elaters are found in the capsules of most members of the Hepaticae and Anthocerotae. Their function and taxonomic usefulness has been discussed by Schuster (1966). Generally, the characters which are useful are spore:elater ratio, the number of spiral strands, the width of the strands, and the overall dimensions. I had not thought about the direction in which the spirals twist until finding a paper on this topic by Dr. Naofumi Kitagawa. Kitagawa (1980) published a short paper in Miscellanea Bryologia et Lichenologia which reports the direction of spiral in the elaters of Hepaticae and Anthocerotae is always sinistrorse (left-handed), with only a very few exceptions. I found this so remarkable that I immediately checked (after teaching myself how to differentiated between left- and right-handed spirals) with preparations I have made of sporangium contents of several dozen species of liverworts of the Pacific Northwest. My results confirm the observation of Kitagawa. Since this phenomenon has not been mentioned in recent general bryological works (Schuster, 1984; Schofield, 1985) I suspect the paper has been overlooked because it is in Japanese (I do not read Japanese, either, and had one of our Japanese graduate students read it for me). However, the English summary succinctly states Kitagawa's results:

"Summary

1) The twining of spiral thickenings was examined on the basis of innumerable elaters in a large number of specimens from various corners of the world.
2) The spiral thickening of elaters was almost universally sinistrorse (left-handed) in the Hepaticae and Anthocerotae.
3) A few exceptions were found in *Conocephalum conicum* and *C. supradecompositum*, where the majority of elaters in a capsule possessed sinistrorse thickenings but the minority (less than ca. 1%) had dextrorse (right-handed) ones.
4) The elaters in *Conocephalum* showed an extraordinarily wide range of variation, and the dextrorse thickenings were found only in the short and thick elaters. This suggested that the exceptional dextrorse elaters might be transformed from the originally sinistrorse ones by the conversion of the axis." (Kitagawa, 1980)

Now, every time I make a preparation of spores and elaters I check the direction of the spiral; to date I have found no deviation from the sinistrorse direction. I would hope that other bryologists with an opportunity to examine liverwort elaters will determine the direction of the twist. If it is truly universal it is indeed remarkable.

Illustrations of elaters in the literature up to this time are not to be trusted for determining the direction of spiral. If a microprojector was used for the drawing, and the elater faithfully copied, then a reverse image is produced (left-handed spirals will come out right-handed in the drawing). More likely, the elater was drawn in the direction most comfortable to the artist without attention given to the possibility that the direction might have some pattern. I have certainly been careless in this regard, until reading Kitagawa's paper. This note is written to call attention to Kitagawa's perceptive observation and to urge bryologists to learn to distinguish sinistrorse spirals from dextrorse ones. Other features besides elaters may reveal interesting patterns of spiraling if examined carefully.

I have checked the spiral of leaves in a few anisophyllous members of the Jungermanniales (direction of spiral is not easily determined in isophyllous taxa) and found it to be quite variable, even on the same shoot. The only pattern which has emerged, in Porella, is that branches on one side of a shoot have leaves spiraling in one direction and leaves of branches on the other side of the leading shoot spiral in the opposite direction.

Kitagawa, N. 1980. The spiral thickenings of elaters in bryophytes is sinistrorse (left-handed). Misc. Bryol. Lichenol. 8: 188-190.

Schofield, W. B. 1985. Introduction to bryology. Macmillan Publishing Company, New York. 431 pp.

Schuster, R. M. 1966. The Hepaticae and Anthocerotae of North America. Vol. 1. Columbia University Press, New York. 802 pp.

_____. 1984. Comparative anatomy and morphology of the Hepaticae. In: R. M. Schuster (ed.), New manual of bryology 2: 760-891. Hattori Botanical Laboratory, Nichinan, Japan.

CHECKLIST OF VERMONT LIVERWORTS

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This list enumerates 129 species, 6 subspecies, 5 varieties and one form of hepatics known or reported from the state of Vermont. The majority of the species were verified from herbarium specimens in the Pringle Herbarium at the University of Vermont. Additional records were added from Schuster (1966-1980). No attempt was made to verify the literature reports. The systematic treatment and nomenclature follows Schuster (1966-1980) for the leafy liverworts and Schuster (1953) and Conard (1979) for the thalloid liverworts.

Much of the state has only been superficially collected. The most frequent collecting sites have been Mount Mansfield, Smuggler's Notch, Lake Willoughby, Leicester Swamp and Colchester Bog. Additions to the flora can be expected as new areas are explored. Further herbarium studies are also likely to turn up new hepatic records for the state.

Anastrophyllum hellerianum (Nees) Schust.
Anastrophyllum michauxii (Web.) Buch & Evans
Anastrophyllum minutum (Schreb.) Schust.
Anthoceros punctatus L.
Asterella tenella (L.) P. Beauv.
Athalamia hyalina (Sommert.) Hatt.
Bazzania denudata (Torrey) Trev.
Bazzania tricrenata (Wahl.) Trev.
Bazzania trilobata (L.) S. F. Gray
Blasia pusilla (L.) Micheli
Blepharostoma trichophyllum (L.) Dum.
Calypogeia fissa (L.) Raddi
Calypogeia fissa subsp. *neogaea* Schust.
Calypogeia muelleriana (Schiffn.) K. Müll.
Calypogeia sphagnicola (Arn. & Perss.) Warnst. & Loeske
Calypogeia suecica (Arn. & Perss.) K. Müll.
Calypogeia trichomanis (L.) Corda
Cephalozia bicuspidata (L.) Dum.
Cephalozia bicuspidata subsp. *ambigua* (Massal.) Schust.
Cephalozia catenulata (Hüben.) Lindb.
Cephalozia connivens (Dicks.) Lindb.
Cephalozia leucantha Spr.
Cephalozia lunulifolia (Dum.) Dum.
Cephalozia macrostachya Kaal.
Cephalozia pleniceps (Aust.) Lindb.
Cephaloziella arctica Bryhn & Douin
Cephaloziella byssacea (Roth) Warnst.
Cephaloziella elachista (Jack) Schiffn.
Cephaloziella hampeana (Nees) Schiffn.
Cephaloziella massalongi (Spr.) K. Müll.
Cephaloziella rubella (Nees) Warnst.
Cephaloziella rubella var. *elegans* (Heeg) Schust.
Cephaloziella stellulifera (Tayl.) Schiffn.
Chandonanthus setiformis (Ehrh.) Lindb.
Chiloscyphus pallescens (Ehrh.) Dum.

Chiloscyphus pallescens var. *fragilis* (Roth) K. Müll.
Cladopodiella fluitans (Nees) Joerg.
Cololejeunea biddlecomiae (Aust.) Evans
Conocephalum conicum (L.) Lindb.
Diplophyllum apiculatum (Evans) Steph.
Diplophyllum taxifolium (Wahl.) Dum.
Fossombronia foveolata Lindb.
Frullania tamarisci subsp. *asagrayana* (Mont.) Hatt.
Frullania eboracensis Gott.
Frullania selwyniana Pears.
Frullania squarrosa (Reinw., Blume & Nees) Dum.
Geocalyx graveolans (Schrad.) Nees
Gymnocolea inflata (Huds.) Dum.
Harpanthus drummondii (Tayl.) Grolle
Harpanthus scutatus (Web. & Mohr) Spr.
Jamesoniella autumnalis (DC.) Steph.
Jubula pennsylvanica (Steph.) Evans
Jungermannia lanceolata L.
Lejeunea cavifolia (Ehrh.) Lindb.
Lejeunea lamacerina subsp. *gemminata* Schust.
Lepidozia reptans (L.) Dum.
Lophocolea bidentata (L.) Dum.
Lophocolea heterophylla (Schrad.) Dum.
Lophocolea minor Nees
Lophozia alpestris (Schleich.) Evans
Lophozia ascendens (Warnst.) Schust.
Lophozia attenuata (Mart.) Dum.
Lophozia badensis (Gott. ex Rabenh.) Schiffn.
Lophozia barbata (Schmid.) Dum.
Lophozia bicrenata (Schmid.) Dum.
Lophozia capitata (Hook.) Boulay
Lophozia collaris (Nees) Schust.
Lophozia excisa (Dicks.) Dum.
Lophozia floerkei (Web. & Mohr) Schiffn.
Lophozia gillmani (Aust.) Schust.
Lophozia hatcheri (Evans) Steph.
Lophozia heterocolpa (Thed.) Howe
Lophozia incisa (Schrad.) Dum.
Lophozia longidens (Lindb.) Macoun
Lophozia marchica (Nees) Steph.
Lophozia porphyroleuca (Nees) Schiffn.
Lophozia ventricosa (Dicks.) Dum.
Lophozia ventricosa var. *silvicola* (Buch) Jones
Mannia fragrans (Balbis) Frye & Clark
Mannia triandra (Scop.) Grolle
Marchantia polymorpha L.
Marsupella emarginata (Ehrh.) Dum.
Marsupella emarginata subsp. *tubulosa* (Steph.) Kitag. var. *latiloba* Schust.
Marsupella sphacelata (Gies.) Dum.
Marsupella sphacelata fo. *media* (Gott.) Schust.
Marsupella ustulata (Hüben.) Spr.
Metzgeria conjugata Lindb.
Metzgeria pubescens (Schrank) Raddi
Microlepidozia setacea (Web.) Joerg.
Moerckia hibernica (Hook.) Gott.
Mylia anomala (Hook.) S. F. Gray
Mylia taylorii (Hook.) S. F. Gray
Nardia scalaris (Schrad.) S. F. Gray
Notothylas orbiculatus (Schwein.) Sull.

Nowellia curvifolia (Dicks.) Mitt.
Odontoschisma denudatum (Nees) Dum.
Pallavicinia lyellii (Hook.) Carruth.
Pellia endiviifolia (Dicks.) Dum.
Pellia epiphylla (L.) Corda
Phaeoceros laevis (L.) Prosk.
Plagiochila asplenioides (L.) Dum.
Plagiochila asplenioides subsp. *porelloides* (Torrey) Schust.
Plagiochila austini Evans
Porella pinnata L.
Porella platyphylla (L.) Pfeiff.
Porella platyphylloidea (Schwein.) Lindb.
Preissia quadrata (Scop.) Nees
Ptilidium ciliare (L.) Hampe
Ptilidium pulcherrimum (Web.) Hampe
Radula complanata (L.) Dum.
Radula obconica Sull.
Radula tenax Lindb.
Reboulia hemisphaerica (L.) Raddi
Riccardia latifrons Lindb.
Riccardia pinguis (L.) Gray
Riccia fluitans L.
Ricciocarpus natans (L.) Corda
Scapania curta (Mart.) Dum.
Scapania cuspiduligera (Nees) K. Müll.
Scapania gymnostomophila Kaal.
Scapania irrigua (Nees) Dum.
Scapania lingulata Buch
Scapania mucronata Buch
Scapania nemorosa (L.) Dum.
Scapania paludicola Loeske & K. Müll.
Scapania paludosa (K. Müll.) K. Müll.
Scapania undulata (L.) Dum.
Scapania undulata var. *oakesii* (Aust.) Buch
Solenostoma caespiticium (Lindb.) Steph.
Solenostoma cordifolium (Hook.) Steph.
Solenostoma gracillimum (Smith) Schust.
Solenostoma hyalinum (Lyell) Mitt.
Solenostoma obovatum (Nees) Schust.
Solenostoma pumilum (With.) K. Müll.
Solenostoma sphaerocarpum (Hook.) Steph.
Trichocolea tomentella (Ehrh.) Dum.
Tritomaria exsecta (Schmid.) Schiffn.
Tritomaria exsectiformis (Breidl.) Schiffn.
Tritomaria quinquedentata (Huds.) Buch

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THE HEPATIC, LICHEN AND MOSS EXCHANGES:
AIDS FOR BEGINNERS AS WELL AS EXPERTS

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Have you seen those exchange notices inside the cover of The Bryologist and wondered what they were all about? Have you questioned whether they could help you, but hesitated to ask? Don't wait--write now!

The American Bryological and Lichenological Society's plant exchanges supply identified samples to beginning students and exotic specimens to expert botanists. Many beginners and amateur naturalists do not have access to cryptogamic herbaria to check their specimens. By obtaining them through a plant exchange a beginner starts his or her own herbarium of specimens for comparison. Experts and even herbaria want exotic material from all over the world. Although some have arranged private plant exchanges, many participate in the Society's exchanges. Excess exsiccati, even isotypes, have been included in the material available. Some experts taken by spring cleaning fervor have shipped their "extras" off to the exchange. No one likes to see good plant specimens wasted, and the exchanges deliver them to eager hands throughout the world.

The exchanges operate very simply--a participant sends in identified duplicate collections of a species and gets "credit" for the number sent (less one sample of each collection, considered as "payment" to the directors for their labors). Periodically (usually twice a year) the director sends the contributors a list of the specimens available and fills the returned orders.

A beginner may well ask "How do I get started--if I can't recognize a species, how do I get 'identified' material to send?" Ask for help--if you don't know an expert in your area write to the exchange director and inquire who might help. Most experts are willing to assist a beginner who sends a limited number of specimens of adequate size complete with collection data. If the specimen is common material, the query is easy to answer; if it's unusual, it's interesting!

Material sent to the exchange should meet the same standards--be specimens in good condition, of adequate size, individually packeted, and with complete collection data on labels. Obviously a collector should not endanger a species by sending large quantities of rare material, but species that are common in one area are unusual in others. I'm always being amazed that someone elsewhere in the world really wants my local weeds! The exchanges do limit the number of duplicate specimens submitted to approximately 6 for common material and 15 for exotic collections. Write to the appropriate exchange director for further details. They are:

Hepatic Exchange: Raymond E. Stotler
Department of Botany
Southern Illinois University
Carbondale, IL 62901

Lichen Exchange: Claire K. Schmitt
Biological Survey
New York State Museum
Room 3132, CEC
Albany, NY 12230

Moss Exchange: Patricia M. Eckel
Clinton Herbarium
Buffalo Museum of Science
Humboldt Parkway
Buffalo, NY 14211

Remember, Australia's weeds are exotic to a New Yorker!

MEGALOSPORA PORPHYRITIS AGAIN: A REPLY TO SIPMAN

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Bronx, NY 10458

In response to the note in this journal proposing the recognition of Megalospora porphyritis (Tuck.) R. C. Harris as a species distinct from M. tuberculosa (Fée) Sipman (Harris, 1984), Sipman has reiterated his preference for synonymizing the two taxa (Sipman, 1986). On the average I would not quarrel with the monographer's decision. In this case, however, I feel that my views have been somewhat misrepresented: "...and should not be treated in the author's opinion as an independent species as proposed by Harris (1984 as Megalospora porphyritis), because of this distribution of the occurrence of pannarin" (Sipman, 1986: 562). Whereas my reasons were that the species "is consistently sorediate, mostly sterile; always contains pannarin and zeorin; has smaller, fewer-celled spores; and has an Appalachian-Great Lakes distribution pattern" (Harris, 1984: 24). In other words, M. porphyritis is distinguishable by a combination of morphological, chemical and historical characters. Sipman (1983, 1986) has emphasized the similarities between the North American, Japanese and Australian populations. This suggests that M. porphyritis actually has an eastern North American-eastern Asian type of distribution pattern. This is a well documented pattern for lichens as well as for bryophytes and higher plants (Culberson, 1972; Kurokawa, 1972). This distribution would imply that M. porphyritis has been distinct from at least the Arcto-Tertiary after which the populations were separated. I feel that a taxon which has maintained its integrity for such a length of time is worthy of recognition at the specific level.

Culberson, W. L. 1972. Distinctive distributions in the lichen-forming fungi. Bryologist 59: 165-173.
Harris, R. C. 1984. Megalospora porphyritis in eastern North America. Evansia 1: 24.
Kurokawa, S. 1972. Probable mode of differentiation of lichens of Japan and eastern North America. In: A. Graham (ed.), Floristics and paleofloristics of Asia and eastern North America. Elsevier, Amsterdam. Pp. 139-146.
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NEW RECORDS FOR BRYOPHYTES OF THE INTERIOR HIGHLANDS OF NORTH AMERICA

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Recent field work in Missouri and Arkansas have resulted in the following new state records for the Interior Highlands of North America.

HEPATICAE

Riccia austinii Steph. Missouri. St. Clair Co.: on open sandy soil, Buzzard Bluff, ca 13 km W of Collins, E 1/4 SE 1/4 Sec. 35, T.37N., R.26W., 2 Nov 1985, *Redfearn 33575b* (MO, SMS).

MUSCI

Bryum miniatum Lesq. Arkansas. Newton Co.: mixed with *Fontinalis* on rock at base of intermittent cliff-side stream, Terrapin Branch, Ozark National Forest, Sec. 30, T.14N., R.23W., 4 Oct 1985, *Allen 4733* (MO, SMS). As indicated by Redfearn (1972), this moss is very close to *Bryum muhlenbeckii* B.S.G. Although the morphological distinctions between these species are not great (some collections of both species exhibit characters in intermediate states), there has been little trouble in separating the two since they are more or less geographically distinct: *Bryum miniatum* is a western and *B. muhlenbeckii* an eastern species. Arkansas, however, lies roughly midway between the distributions of these two species. Furthermore, when evaluating the validity of maintaining two species for this obviously close complex one should keep in mind that both species are semi-aquatic and a certain amount of morphological variation within the species should be expected.

Forsstroemia producta (Hornsch.) Par. Arkansas. Newton Co.: on branch of tree, Lost Valley Park, Buffalo National Scenic Riverways, SE 1/4 Sec. 25, T.16N., R.23W., 3 Oct 1985, *He 34401* (MO, SMS). This moss has long been known in North America as *F. ohioensis* (Sull.) Lindb. Stark (1985), however, found *F. ohioensis* to be synonymous with the widespread, but principally Southern Hemispheric (South America, Africa, Australia, and China), *F. producta*.

Hygrohypnum eugyrium (B.S.G.) Loeske Arkansas. Newton Co.: on shaded vertical sandstone of N-facing bluff, Terrapin Bluff, Ozark National Forest, Sec. 30, T.14N., R.23W., 4 Oct 1985, *He 34511* (MO, SMS), *Redfearn 33533* (DUKE, MICH, MO, SMS, US). After examining a duplicate of *Redfearn 33533*, Dr. Howard Crum found the alar cells only slightly differentiated and considered this moss similar to *Hygrohypnum subeugyrium* (Ren. & Card.) Broth. We believe the distinctions between

H. eugyrium and *H. subeugyrium* are, at best, weak. After examining a number of leaves from the above collections we found that many had obviously differentiated alar cells that matched those illustrated by Jamieson (1976) for *E. eugyrium*. Furthermore we have examined collections of *H. eugyrium* from North Carolina (MO) that appear identical in all respects to the above collections. Therefore, we have assigned these Arkansas collections to that species.

Hypnum cupressiforme Hedw. var. *resupinatum* (Tayl. *ex* Spruce) Schimp. Missouri. Shannon Co.: in crevice of vertical felsite on N-facing bluff, Sec. 15, T.29N., R.3W., ca 8 km NE of Eminence, 26 Oct 1985, *Redfearn 33565* (MO, SMS).

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FLUORESCENCE ANALYSIS AS A TAXONOMIC CRITERION FOR CRUSTOSE LICHENS

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Introduction

Identification and taxonomy of lichens is routinely based on various combinations of apothecial and thalloid or vegetative characters (Poelt, 1974). Chemical tests have been used for many years as an aid in lichen taxonomy. Nylander in the 1860s devised the first practical method of identifying colorless lichen compounds by adding potassium hydroxide or calicium hypochlorite to the thallus and observing color changes. These color tests and others such as addition of p-phenylenediamine are now utilized by most lichenologists. More than 200 chemical substances are produced by lichens. Commonly encountered lichen substances include depsides, depsidones, xanthones, anthraquinones, chromones and naphthoquinones. In addition to the color tests used by Nylander, several other analytical tests are available for detecting lichen substances. Microchemical crystalization tests introduced by 1900, were simplified and standardized by Asahina in Japan during the 1930s and have been replaced by more accurate chromatographic methods.

The introduction of paper chromatography allowed more rapid studies of large numbers of specimens (Wachtmeister, 1952). Thin layer chromatography with its increased sensitivity has allowed detection and identification of many new compounds (Santesson, 1967). Since its introduction, gas chromatography has had very limited use primarily because many lichen compounds are insufficiently volatile or are too unstable at high temperatures to be analysed (Shibata et al., 1965). A few lichen substances, including usnic acid, ethanol-soluble carbohydrates and polyols, have been successfully studied using gas chromatography (Fahselt, 1975; Gordy et al., 1978). Electrophoresis is not useful for the largely water-insoluble lichen substances but can be used for proteinaceous compounds (Hale, 1983). More recent equipment applied to lichen research includes high pressure liquid chromatographs and mass spectrophotometers (Culberson, 1969; Santesson, 1974). Some of these latest technological advances are beyond the reach of amateurs and most professional lichenologists.

One other technique which is often useful, is easy to use, and is available to most investigators, is fluorescence analysis. The technique was first used by Chernohorsky (1950) and Ozenda (1951) as an aid in species identification although no cause of the phenomenon was reported. Fluorescence of nine lichen depsides and depsidones as a taxonomic criterion was reported by Hale (1956). When held under a long wave (366 nm) ultraviolet light, the depsides and depsidones studied fluoresced bright white to bluish or greenish-white. Other lichen compounds such as anthraquinones appear brick-red, while xanthones fluoresce bright yellow to orange-red. Addition of a drop of alkali, e.g., K reagent, will often change the fluorescence (Santesson, 1974).

Several macrolichen species known to fluoresce are reported in various references including the standard introductory text by Hale (1979). In his taxonomic study of Pertusaria, Dibben (1980) incorporated fluorescence as a major criterion in the keys to species of the genus. Little information has been published concerning fluorescence of crustose species. Because of the difficulty in differentiating members of this group and the

Table 1. Fluorescence Analysis of Crustose Lichens

Species	Color Emitted
Acarospora cervina	None
Acarospora chlorophana	None
Anthracothecium ochraceoflavum	None
Arthonia tumidula	None
Arthroraphis alpina	Reddish-orange
Aspicilla cinerea	None
Bacidia chlorantha	None
Caloplaca citrina	Red
Caloplaca feracsissima	Red
Caloplaca saxicola	Red
Candelariella aurella	None
Candelariella efflorescens	None
Candelariella vitellina	Reddish-orange
Chiodecton sanguineum	None
Chrysothrix candelaris	None
Conotrema urceolatum	None
Graphis afzelii[a]	Bluish-white
Graphis dumastii[a]	Bluish-white
Graphis elegans	None
Graphis leucopepla	Orange
Graphis scripta	None
Haematomma cismonicum	None
Haematomma coccineum	None
Haematomma ochrophaeum	None
Haematomma puniceum	None
Laurera madreporiformis	None
Lecanactis premnea[a]	Green
Lecanora caesiorubella	None
Lecanora dispersa	None
Lecanora muralis	None
Lecanora pallida	None
Lecanora polytropa	None
Lecanora rugosella	None
Lecanora subfusca	None
Lecanora symmicta	None
Lecanora varia	None
Lecidia helvola	None
Lecidia russula	Yellow
Lepraria incana	None
Lepraria finkii	None
Lepraria zonata	None
Leptoraphis epidermidis	None
Mycoblastus sanguinarius	None
Myriotrema compunctum	None
Ocellularia granulosa	None
Ochrolechia pseudopallescens	None
Pertusaria amara	None
Pertusaria hypothamnolica	Yellow
Pertusaria multipunctoides	None
Pertusaria texana	Reddish-orange
Pertusaria velata	None

[a] Apothecia only

Table 1 (Cont.)

Species	Color Emitted
Porpidia flavocaerulescens	None
Porpidia macrocarpa	None
Psilolechia lucida	Reddish-orange
Pyrenula cerina	Red
Pyrgillus americanus	Yellow
Rhizocarpon geographicum	Reddish-orange
Rhizoplaca chrysoleuca	None
Trypethelium aenum	Reddish-orange
Trypethelium tropicum	None
Cladina evansii[b]	None
Cladonia squamosa[b]	White
Hypotrachyna formosana[b]	Orange

[b] Control species

simplicity of testing, it was decided to investigate the use of fluorescence analysis as an aid to identification of crustose species.

Materials and Methods

A long wave (366 nm) Black-Ray ultraviolet lamp (American Scientific Products, Edison, NJ) was used to determine fluorescence for all lichen species studied. Crustose lichens were collected from a variety of substrates in several locations throughout the United States. Two species collected in the Galapagos Islands were also analysed. Vouchers are deposited in the herbarium of Utica College of Syracuse University. Collections were air-dried at room temperature for a minimum of one week before testing for fluorescence. Specimens were placed in a dark room and exposed at 10-20 cm from the u.v. lamp. All portions of the lichen thallus and reproductions structures were examined for fluorescence color and results were recorded.

Results and Discussion

Sixty species of crustose lichens were examined for fluorescence under long wave ultraviolet light. The results are shown in Table 1. Positive and negative controls were also tested and are included in the table. The thallus of fourteen species exhibited intense fluorescence ranging in color from yellow to reddish-orange and bright red. The apothecia of three additional species were positive despite negative fluorescence of the thallus. Fluorescence was either intense or absent. No weak or questionable responses were observed. Exposure to u.v. light does not differentiate between various compounds that exhibit the same color of fluorescence. For example, at least nine widely distributed substances emit indistinguishable white light. Chromatography or other specific testing is required for precise identification of lichen substances. However, u.v. light can be used to quickly sort specimens into groups or to differentiate between species which have a similar external appearance. In addition, fluorescence analysis adds a major criterion for identification of a complex and difficult group of lichens.

Acknowledgments

I thank Mason E. Hale, Jr. for reading the manuscript, contributing valuable suggestions for improvement, and providing identification for some of the species studied. I also thank Richard Harris for confirming and identifying several of the species used in this investigation.

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FERTILE COLLECTIONS AND DISTRIBUTION RECORDS OF PELTIGERA DIDACTYLA (PELTIGERACEAE) IN NEW YORK STATE

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The small terricolous lichen Peltigera didactyla (With.) Laundon, until recently known as P. spuria (Ach.) DC., is characterized by large laminal soralia on the upper surface of the thallus. Hale (1979: 49) showed it to be widely distributed in the Northeast, Midwest and West in North America, and stated that its apothecia are "very rare." Taylor (1967: 112) mapped its known distribution in Ohio (12 counties), and also described its apothecia, which he had not seen on Ohio material, as "very rare."

I have collected this lichen over several years in various parts of New York State, often in fertile condition. The following catalogue gives my New York collections by locality, with notes on apothecia, habitats and distribution of specimens. (R.D. is my personal herbarium.)

CATSKILL MOUNTAINS

DELAWARE COUNTY: Hancock Town, Pea Brook, on large, dead, fallen hemlock (*Tsuga canadensis*) log in full sun, in beaver meadow, with well developed apothecia, *L-620* (NY, R.D.); Tompkins Town, bank of State Rt. 10, Cannonsville Reservoir, with apothecia, *L-425* (NY, R.D.).

SULLIVAN COUNTY: Fremont Town, N edge of State Rt. 97 at The Basket, new Long Eddy, *L-624* (with apothecium, NY, R.D.), *L-1613* (R.D., intergrown with *Philonotis fontana* [*M-204*]).

CHEMUNG PINE BARRENS

CHEMUNG COUNTY: Chemung Town, S bank of State Rt. 17, 1.6 km W of Exit 59A, fertile, *L-1413* (NY).

FINGER LAKES

SENECA COUNTY: Waterloo Town, S bank of Dunham Rd., 1.6 km W of County Rt. 108, on sand, *L-81* (NY, R.D.).

GLENS FALLS SAND PLAIN

WARREN COUNTY: Queensbury Town, Glens Falls, N bank of Peggy Ann Rd., with apothecia, *L-1074* (NY, NYS, R.D.).

KARNER PINE BUSH

ALBANY COUNTY: Town of Guilderland and City of Albany, along utility pole rights-of-way, *L-73* (NY, R.D.), *L-572* (R.D.), fertile, *L-800* (NY, R.D., US), *L-855* (R.D.); on sand in open pine barrens, *L-144* (NYS, R.D.), *L-145* (NY, R.D.); in interdune flats, terricolous in litter, very luxuriant, covering 1 m^2 area, *L-582* (R.D.), fertile, between *Andropogon* hummocks, *L-813* (NY, NYS, R.D.); on eroding sandy banks of roads or trails, at interface with pine barrens vegetation, fertile, *L-681* (NY, NYS, R.D.), fertile, *L-682* (NY, NYS, R.D., US), *L-756, L-757* (both R.D.), with apothecia, *L-768* (NY, NYS, R.D.), fertile, *L-770* CANL, DUKE, NY, R.D.), with apothecia, *L-774* (NY, NYS, R.D., US), *L-786, L-787, L-939* (all R.D.).

Peltigera didactyla is a species of xeric habitats, where it grows in nearly full sun on unstable or recently disturbed sandy soil, or rarely on duff or lignum. In New York, typical habitats are exposed road banks or along sand roads and trails in pine barrens. Even in relatively moist places, as in beaver meadows (see *L-620* under CATSKILLS, above), it grows in hot, sun-baked situations.

About half of the collections listed are fertile. As I made no attempt to selectively collect thalli with apothecia, this implies that fertile thalli occur much more frequently than has been supposed. Even at the Pine Bush, which I have carefully surveyed for lichens, 8 of 19 collections reported were fertile (this includes Milne 126, a fertile collection in NYS).

I suspect that this lichen is a short-lived, early successional perennial with a life span of three to four or possibly six years. A scrutiny of Pine Bush specimens, my largest sample from one place, suggests these stages in thallus development: (1) YOUNG INFERTILE THALLUS: small, saucer-like, colonial thalli, 1-6 mm in diameter, with some small soredia (*L-756, L-855, L-939*). (2) FULLY GROWN INFERTILE THALLUS: larger thalli, approaching or exceeding 1 cm in diameter, and sometimes reaching 2-3 cm across, with large, obvious, orbicular soralia; at this point a few white scars of eroded soredia may also be apparent (*L-73, L-144, L-145, L-572, L-582, L-757, L-786, L-787*). (3) MATURE THALLUS: apothecial development begins, at first broad and curled inward over the concave thallus body (*L-682, L-800*), later fertile branches lengthen to 2-3 cm and stand erect, the terminal apothecia 4-5 mm long, turning dark purplish-brown (*L-681, L-768, L-813*); whitish scars of shed soralia are evident at this stage. (4) THALLUS DEATH: thalli blacken and may be overgrown by algae or Cladonia squamules (*L-770, L-774*). The fertile stages may not be reached by all thalli.

Richard C. Harris (NY) determined two fertile collections from the Catskills, and C. Richard Prince (formerly NY) confirmed by identifications of early collections from several localities. Nina Shishkoff (CUP) reviewed a draft of this paper.

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PRELIMINARY ANNOTATED LIST OF BRYOPHYTES OF THE PINE BUSH, ALBANY COUNTY, NEW YORK, AND VICINITY

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Introduction

This is a record of bryophytes collected at the Pine Bush, Albany County, New York, between 1976 and 1986.

The Pine Bush is a large pine barrens on stabilized sand dunes between Albany and Schenectady, New York. Its origin dates back to 15,000-12,000 years BP, when an ice dam blocked the lower Hudson River valley during glacial recession. The resultant glacial lake filled the Hudson valley from near present-day Newburgh to Glens Falls, and the "Glaciomohawk" River formed a large delta where it flowed into the lake. The pine barrens vegetation found on this delta by the first European settlers originally covered 40 square miles, but has since been reduced to ca. 4000 acres by human developments. The Pine Bush has proved rich in rare species and peripherally isolated populations in groups that have been well studied, including reptiles and amphibians (Steward & Rossi, 1981), vascular plants (Eights, 1835-1836; Ritter, 1941; Rittner, 1976), and butterflies (Lintner, 1872, 1873; and my unpublished records). Details of glacial, geological, natural and human history of the Pine Bush may be found in Rittner's (1976) anthology Pine Bush—Albany's Last Frontier. Further results of Pine Bush field research have been published in the journal "Skenectada" since its inception in 1979; it is available from the American Pine Barrens Society, Inc., 6A Picturesque Parkway, Schenectady, NY 12303.

Pine Bush bryophytes are relatively poorly known. Charles H. Peck, Homer D. House and Stanley J. Smith of NYS, as well as other botanists, have collected mosses intermittently in the region. Andrus (1980) and Ketchledge (1980) included some Pine Bush records in their respective accounts of *Sphagnum* and mosses of the state. However, to my knowledge, no exhaustive, specimen-documented survey of the bryophytes of this sand plain has been made. This is unfortunate, since the Pine Bush is a mosaic of xeric dune habitats, shaded mesic ravines, kettle bogs, marshes, and swamps where many mosses and liverworts grow. The preliminary list presented here provides a bryological baseline for the Pine Bush similar to those of Dean (1976), Haines (1976), and Rittner (1979) for the fungi, and Milne (1979) for the lichens. A few records of mosses from nearby pine barrens in New York and in the parallel Connecticut River valley of western Massachusetts are also included.

Methods

Bryophytes were collected as part of a general floristic survey of the Pine Bush which was begun in 1976 and continued every year since except 1981. Except for the peat mosses (*Sphagnum*), which I have given special attention, bryophyte collecting has been incidental to other field work. Most of the species included in the following list are common or obvious, but some of the Pine Bush Sphagna (which will be treated elsewhere [Dirig, in press] and are only listed here) are rare or unusual, and were found after deliberate searches. Cited specimens are all R. Dirig collections deposited in BH, BING, DUKE, NYS, and in my personal herbarium (=R.D.).

A few moss collections were made in several other large tracts of remnant pine barrens vegetation which occur within a few miles of Albany. All localities mentioned in the Species List are explained below:

PINE BUSH: New York, Albany County, Towns of Guilderland and Colonie and the City of Albany. Sampled tracts are roughly bounded by Rt. 20, Fuller Rd., Rt. 5, and Willow St./Siver Rd./Morris St.; elevations 300-350 ft. The East Branch of the Hunger Kill and the Kaikout Kill (streams) flow rapidly over sand beds in deep ravines in this area. Swampy and marshy wetlands occur between the Penn Central Railroad and Rt. 5. The most xeric area of nearly virgin pine barrens vegetation on high dunes is bounded by Rt. 90 (NYS Thruway), Old State Rd. and the railroad, and Rapp Rd.

SHAWANGUNKS: New York, Ulster County, Town of Wawarsing, Ice Caves Mountain National Landmark, near Lake Maratanza; elevation ca. 2260 ft. Pine barrens vegetation atop a large ridge of white quartzite conglomerate. A dwarf form of pitch pine (*Pinus rigida*), similar to that of the New Jersey and Long Island pine barrens "plains," occurs in this windswept pine barrens (Olsvig et al., 1979; Olsvig, 1980).

ALTONA: New York, Clinton County, Town of Altona, "Flat Rock" area 3000-10,000 ft SE of Altona; elevations 800-900 ft. An extensive native jack pine (*Pinus banksiana*) barrens on horizontal outcrops of Potsdam sandstone.

GLENS FALLS: New York, Warren County, Town of Queensbury, area W of Rt. 87 and S of Aviation Rd.,; elevations 350-480 ft. The most thoroughly explored area is the deep ravine of Halfway Creek and adjacent pine barrens, N of Peggy Ann Rd. A large pine barrens once occupied the Glen Falls Sand Plain, but it has been largely destroyed by human activities. This is the northernmost part of the upper Hudson River valley sand belt, ca. 45 mi N of the Pine Bush in the same system.

ROME: New York, Oneida County, Town of Rome, Rome Sand Plains, area surrounding the intersection of the Penn Central Railroad tracks and Humaston Rd.; elevation ca. 460 ft. This pine barrens is badly disturbed and poorly known.

MONTAGUE: Massachusetts, Franklin County, near Turners Falls, Montague Sand Plains, large sand delta bounded by Rt. 63 on the E, on the S by Swamp Rd., on the W by Montague Rd., and on the N by Hillsdale Rd. and Millers Falls Rd. Along Plain Rd., which cuts through the sand plain; elevations 300-350 ft. A large, obscure tract of pine barrens vegetation.

WESTFIELD: Massachusetts, Hampden County, Town of Westfield, Westfield Pine Barrens, grounds of the Westfield Barnes Municipal Airport S of Buck Pond Rd., E of Southampton Rd. (Rt. 202), W of East Mountain Rd. and Owen-District Rd., and N of Rt. 90 (Massachusetts Turnpike); elevation ca. 250 ft. Badly disturbed pine barrens vegetation on gravelly sand.

Species List

Hepatics

Conocephalum conicum (L.) Dum. PINE BUSH: East Branch Hunger Kill ravine, 29 Sep 1978, *H-10* (BH, NYS, R.D.); Kaikout Kill headwaters, 28 Sep 1984, *H-13* (BH, NYS, R.D.).

Marchantia polymorpha L. PINE BUSH: With archegonia, Kaikout Kill headwaters, 15 Oct 1979, *H-9* (BH, R.D.).

Mosses

Moss nomenclature used below follows Crum & Anderson (1981) except for *Sphagnum*, which follows Andrus (1980).

Atrichum angustatum (Brid.) B.S.G. PINE BUSH: On sandy rim of Kaikout Kill ravine, 28 Sep 1984, *M-236* (BH, NYS, R.D.).

Aulacomnium palustre (Hedw.) Schwaegr. PINE BUSH: On hummock in swampy woodland, Colonie, 8 Oct 1977, *M-209* (BH, NYS, R.D.).

Bryum argenteum Hedw. PINE BUSH: On disturbed sand in open pine barrens, 23 Sep 1976, *M-59* (BH, R.D.), 1 Oct 1977, *M-208* (BH, R.D.). SHAWANGUNKS: On exposed bedrock, 17 Sep 1976, *M-94* (BH, R.D.).

Bryum pseudotriquetrum (Hedw.) Gaertn., Meyer & Scherb. SHAWANGUNKS: On exposed bedrock, 17 Sep 1976, *M-93* (DUKE, R.D.).

Callicladium haldanianum (Grev.) Crum PINE BUSH: Lignicolous on fallen, fire-scarred *Pinus rigida*, 2 Oct 1977, *M-211* (BH, NYS, R.D.).

Campylium chrysophyllum (Brid.) J. Lange PINE BUSH: Corticolous on very large *Salix*, 8 Oct 1977, *M-206* (BH, NYS, R.D.).

Ceratodon purpureus (Hedw.) Brid. PINE BUSH: On sand in open pine barrens, 23 Jun 1976, *M-54* (BH, R.D.), 23 Sep 1976, *M-60* (NYS, R.D.), *M-61* (BH, R.D.).

Climacium americanum Brid. PINE BUSH: Large mats in bed of East Branch Hunger Kill, 19 May 1979, *M-199* (BH, R.D.).

Dicranella heteromalla (Hedw.) Schimp. SHAWANGUNKS: Trail in pine barrens, 23 Apr 1977, *M-111* (BH, NYS, R.D.).

Fontinalis antipyretica Hedw. PINE BUSH: Attached to substrate, floating over sandy bed in a foot of shaded water, East Branch Hunger Kill, 25 May 1979, *M-272* (BH, DUKE, R.D.).

Hedwigia ciliata (Hedw.) P.-Beauv. ALTONA: Large mats on horizontal bedrock, 7 Aug 1979, *M-202* (BH, R.D.).

Hypnum pallescens (Hedw.) P.-Beauv. PINE BUSH: Corticolous at base of *Populus deltoides*, 8 Oct 1977, *M-207* (BH, NYS, R.D.).

Leucobryum glaucum (Hedw.) Ångstr. ex Fr. PINE BUSH: Dry woods, under large *Quercus*, 28 Sep 1984, *M-237* (BH, R.D.).

Mnium affine Bland. ex Funck PINE BUSH: East Branch Hunger Kill ravine, 19 May 1979, *M-200* (BH, NYS, R.D.), 25 May 1979, *M-210* (BH, R.D.).

Philonotis fontana (Hedw.) Brid. PINE BUSH: On soggy sand in open areas, 10 Mar 1980, *M-185* (R.D.), 27 May 1985, *M-283* (BH, NYS, R.D.). GLENS FALLS: Halfway Creek ravine, on wet sand, 29 May 1985, *M-285* (BH, NYS, R.D.).

Pohlia nutans (Hedw.) Lindb. PINE BUSH: On disturbed wet sand, with *Drosera rotundifolia*, *Lycopodium inundatum* and *Polytrichum commune* (*M-212* below), Colonie, 21 May 1977, *M-213* (DUKE, R.D.).

Polytrichum commune Hedw. PINE BUSH: Solid mat of several square yards in open pine barrens, 31 May 1979, *M-183* (BH, NYS, R.D.), with *Pohlia nutans* (*M-213* above), 21 May 1977, *M-212* (BH, R.D.). ROME: On wet sand, 22 Sep 1979, *M-186* (BH, R.D.). MONTAGUE: Terricolous, 10 Jun 1979, *M-174* (BH, R.D.). WESTFIELD: Terricolous, 28 May 1979, *M-95* (BH, R.D.).

Polytrichum juniperinum Hedw. SHAWANGUNKS: Terricolous on wet hummock, intergrown with *Cetraria arenaria*, 17 Sep 1976, *M-95* (BH, R.D.).

Rhodobryum roseum (Hedw.) Limpr. PINE BUSH: Kaikout Kill ravine, 28 Sep 1984, *M-240* (BH, NYS, R.D.).

Sphagnum affine Ren. & Card. [= *S. imbricatum* Russow] PINE BUSH: Wooded wetland.

Sphagnum angustifolium (Russow) C. Jens. PINE BUSH: Wooded wetlands.

Sphagnum centrale C. Jens. PINE BUSH: Wooded wetlands.

Sphagnum compactum DC. PINE BUSH: Interdune "boglets." A discussion of fruiting in this fire climax species will be published elsewhere (Dirig, in press).

Sphagnum cuspidatum Hoffm. PINE BUSH: Kettle bogs.

Sphagnum fallax (Klinggr.) Klinggr. PINE BUSH: Kettle bogs. ROME: On wet sand, 22 Sep 1979, *M-188* (BH, BING).

Sphagnum fimbriatum Wils. PINE BUSH: Wetlands.

Sphagnum flexuosum Dozy & Molk. PINE BUSH: Kettle bogs.

Sphagnum fuscum (Schimp.) Klinggr. PINE BUSH: Wetlands.

Sphagnum girgensohnii Russow PINE BUSH: Ravines.

Sphagnum henryense Warnst. PINE BUSH: Ravines, marshes. GLENS FALLS: Halfway Creek ravine, 29 May 1985, *M-286* (BH, BING, R.D.).

Sphagnum lescurii Sull. PINE BUSH: Marshes.

Sphagnum magellanicum Brid. PINE BUSH: Kettle bogs. ROME: On wet sand, 22 Sep 1979, *M-187* (BH, BING).

Sphagnum nemoreum Scop. PINE BUSH: Marshes, ravines.

Sphagnum palustre L. PINE BUSH: Wooded wetlands.

Sphagnum platyphyllum (Braithw.) Warnst. PINE BUSH: Marshes.

Sphagnum squarrosum Crome PINE BUSH: Wooded wetlands.

Sphagnum subsecundum Nees PINE BUSH: Marshes.

Sphagnum teres (Schimp.) Ångstr. GLENS FALLS: Halfway Creek ravine, 29 May 1985, *M-287* (BH, BING, R.D.).

Sphagnum torreyanum Sull. PINE BUSH: Kettle bogs.

Discussion

Two liverworts and 34 mosses (including 19 Sphagna) have been collected from the Pine Bush during the last decade. Undoubtedly this is but a fraction of the mosses that occur there, since Ketchledge (1980) listed 30 Sphagna and 260 other mosses from Distributional District 18 of New York State, which includes the Pine Bush. This District also harbors the extensive limestone ridge of the Helderbergs, south of Albany; part of Saratoga County, N of the Mohawk River, which has extensive pine barrens and two large kettle lakes with boggy fringes; and Columbia and Rensselaer Counties, E of the Hudson, which also have boggy wetlands and the Taconic Mountains. With such a diversity of habitats, one would expect the number of species recorded for the whole district to exceed the number in the Pine Bush. The species I have found are all common and widely distributed in North America (Crum & Anderson, 1981), except for Sphagnum platyphyllum and S. torreyanum (Andrus, 1980). There must also be additional liverworts in the Pine Bush.

Pine barrens vegetation occurs sparingly in the Northeast. Cryan (1984) presented a table of 22 major pine barrens and their estimated original and remaining acreages, and characterized this as the rarest vegetation type in the East. He also warned that it is disappearing at an alarming rate, since many pine barrens occur on sand deltas near major waterways where large human settlements have grown. The Pine Bush is no exception, but through the ongoing efforts of several local environmental groups, particularly the American Pine Barrens Society, Inc. (formerly the Pine Bush Historic Preservation Project, Inc.), Save the Pine Bush, Inc., and The Nature Conservancy, ca. 1000 acres of pristine vegetation have been preserved. This includes parts of two kills and virgin tracts of xeric dune vegetation which still exists within the City of Albany, one of the oldest cities on the continent!

I hope this paper will encourage further work on Pine Bush and pine barrens bryophytes. A survey of Pine Bush species or a comparative study of species found in several northeastern pine barrens would make a good master's or doctoral dissertation project in bryology.

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Ketchledge (SYRF). Logistical assistance in the field was provided by Thomas Carrolan, Cryan, Hollister, Rittner and Philip Walker. Fred Grau facilitated natural history collecting and exploration at Ice Caves Mountain National Landmark in the Shawangunks. Officials of the Westfield Barnes Municipal Airport in Massachusetts likewise permitted collecting on their grounds. Part of the specimens were collected as documentation for a Pine Bush natural history journal during my year with the Pine Bush Historic Preservation Project in 1979-1980. Edward A. Cope (BH) and Nina Shishkoff (CUP) reviewed a draft of this paper and made helpful suggestions.

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WEISSIA PHASCOPSIS (= ASTOMUM PHASCOIDES) NEW TO THE MOSS FLORA OF NEW MEXICO, WITH ADDITIONAL COUNTY RECORDS

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Interest in the moss flora of the state of New Mexico, U.S.A., was piqued by the preliminary checklist for the state published by Mahler (1978), and subsequently extended by Ireland et al.(1981, 1984), Stark & Castetter (1982) and Mahler (1985). As part of a larger study of western aridland masses, I collected extensively in the state in 1985; the present paper reflects two stations of those investigated. *Weissia phascopsis* is reported new to New Mexico.

Weissia phascopsis Zand. U.S.A., New Mexico. Luna County: 5 mi S of Deming on NM 11, off partially paved road 9 mi E of jct. with NM 11, Rockhound State Park, Florida Mountains, S-facing slope, ca. 5500 ft, ravine in hillside, sclerophyllous scrub, with *Opuntia, Juniperus, Pellaea* spp., 16 Jun 1985, *Eckel 1631986, 212386* (BUF).

The Florida Mountains are part of the Basin and Range Physiographic Province, Mexican Highlands section, which includes southeastern Arizona and western Texas (Fenneman, 1946). The desert mountains of this geographic section have been described as a center for diversification of the genus *Weissia* (Bartram, 1927; Stoneburner & Wyatt, 1985). This generalization is borne out by the high number of congeneric species in this one locality (including *Weissia controversa*, *W. condensa* and *W. ligulaefolia*, as noted below).

The geographic range of *Weissia phascopsis* is indicated by reports of stations in Alberta-Saskatchewan, Nebraska, Texas, Quebec, Ohio, Virginia, Minnesota and Arizona (Crum & Anderson, 1981).

Weissia phascopsis and *W. ligulaefolia*, associated with it at this locality, are not known from Mexico (Zander, 1986), but they will probably be found readily there if collections were made in the mountains south of the the border with the United States in the Mexican states of Chihuahua and Sonora. The present station is only 30 miles north of the Mexico-U.S.A. border.

Associated species growing in the same ravine and constituting new county records and, in some cases, second state collections are as follows. All collecting numbers are the author's. Specimens are deposited at BUF. *Bryum argenteum* Hedw., *731986; Bryum capillare* Hedw., *331986; Ceratodon purpureus* (Hedw.) Brid., *631986; Fabronia ciliaris* (Brid.) Brid., *1731986; Phascum cuspidatum* L. ex Hedw., *1031986; Tortula bartramii* Steere, *131986, 531986; Tortula norvegica* (Web.) Wahlenb., *231986, 531986; Tortula rhizophylla* (Sak.) Iwats. & Saito, *1831986; Tortula ruralis* (Hedw.) Gaertn., Meyer & Scherb., *2203086; Weissia condensa* (Voit) Lindb., *82036; Weissia controversa* Hedw., *121586*.

Weissia condensa has been reported from Arizona, Colorado, Kansas, Texas, Utah and New Mexico (Stoneburner, 1985). Mahler (1978) cited a report for this species by Bartram (1931; as *W. tortilis* (Schwaegr.) C. Müll.) for San Miguel Co., but with the annotation that this taxon had been excluded from North America by Crum, et al. (1973). Stoneburner (1985) summarized the arguments for the decision to exclude this taxon, and reinstated it in the North American flora based on collections seen from Arizona and Texas. The occurrence of *W. condensa* in New Mexico bears out Stoneburner's observations that it "appears to be evenly distributed throughout the Southwest" (Stoneburner, 1985). The following specimen and the one reported above constitute the second and third reported collections for the state, after Bartram (1931).

Weissia condensa (Voit) Lindb. U.S.A., New Mexico. Quay County: on Rt. 39, 6 mi S of I-40 and San Jon. Bluffs of the Llano Estacado; protected gully (elev. at Gary 4500 ft) with shrubby *Quercus* and *Rhus* spp., 12 Jul 1985, *Eckel 720386* (BUF).

Associated species growing in the same ravine and constituting new county records for the state are:
Barbula unguiculata Hedw., *221486; Didymodon rigidulus* var. *gracilis* (Schleich.) Zand., *119686; Fissidens obtusifolius* var. *acuminatus* Grout, *620386a; Grimmia raui* Aust., *420386; Molendoa sendtneriana* (B.S.G.) Limpr., *320386; Orthotrichum diaphanum* Brid., *121486; Pseudocrossidium replicatum* (Tayl.) Zand., *652086; Weissia controversa* Hedw., *620386.*

I thank Richard Zander for verifying the identifications of some of the additional records, Terry McIntosh for determining _Grimmia raui_, and Ann Stoneburner for determining and discussing the specimen of _Weissia ligulaefolia_.

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THE GENUS SPHAGNUM IN PANAMA

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Many acquainted with *Sphagnum* in the Northern Hemisphere will likely be surprised on encountering the genus in Panama. Although some Panamanian species of the genus occur in traditional, terrestrial types of habitats, the genus is just as frequently found as an epiphyte. Indeed, in some cloud forest areas, *Sphagnum* can be found dominating the upper crotches of canopy trees (i.e., 10-15 m from the ground).

An examination of Panamanian *Sphagnum* collections at MO indicates that the genus in Panama is represented by two sections and four species: *S. magellanicum*, *S. perichaetiale*, *S. alegrense* (all sect. *Sphagnum*) and *S. meridense* (sect. *Acutifolium*). The most remarkable morphological feature of section *Sphagnum* in Panama is found in the poor expression of stem and branch cortical spiral fibrils. This character, usually the easiest means of recognizing the section, is found only at the tips of some branches in both *S. alegrense* and *S. perichaetiale*. All collections examined are deposited at MO, additional reports are deposited at CR.

A preliminary examination of the genus *Sphagnum* in Costa Rica indicates that the genus is more diverse there than in Panama. Indeed, Crum (pers. comm.) has seen the following species in Costa Rica: *S. cuspidatum*, *S. limbatum*, *S. sancto-josephense*, *S. sparsum*, *S. strictum* and *S. subsecundum* var. *rufescens*. Since the mountains of western Panama and eastern Costa Rica represent the same range it seems likely that further collecting in this region of Panama will increase the number of species found in Panama. In addition, further collecting in the Darien region of Panama, which has never been extensively collected for mosses, will probably yield at least a few new "South American" species of *Sphagnum* for the country. This study, therefore, is best viewed as a preliminary account of the genus *Sphagnum* in Panama.

KEY TO THE SPECIES OF SPHAGNUM IN PANAMA

1. Branch leaves broad, cucullate-concave, roughened at back of apex from resorption of hyaline cells; stem leaves not bordered by linear cells; branch cortex sometimes with delicate spiral fibrils 2
    2. Green cells of branch leaves narrowly rectangular (rarely lenticular, occasionally ± triangular), exposed on both surfaces because of thickened cell ends .... 1. *S. perichaetiale*
    2. Green cells of branch leaves central and entirely included 3
        3. Stem cortical cells with delicate spiral fibrils; branch leaf hyalocysts lacking short, vermiform ridges on the inner side walls .... 2. *S. magellanicum*
        3. Stem cortical cells lacking fibrils; branch leaf hyalocysts with short, vermiform ridges on the inner side walls .... 3. *S. alegrense*
1. Branch leaves narrower, tapered to a slender, truncate apex, involute-concave, not cucullate or roughened at apex; stem leaves bordered by linear cells; branch and stem cortex without delicate spiral fibrils .... 4. *S. meridense*

1. *Sphagnum perichaetiale* Hampe

Descriptions and illustrations: Warnstorf, 1911; Eddy, 1977; Crum, 1980; Crum & Anderson, 1981; Crum, 1984.

Specimens examined. COCLE: Cerro Gaital, N of El Valle, 8°40'N, 80°07'W, 1000-1400 m, *Knapp et al. 5987*. PANAMA: Cerro Jefe, near Radio Tower, 900 m, *Folsom 3624; D'Arcy et al. 15518; Allen 4910, 4965, 4966, 4967*; Cerro Jefe, trail leading W from summit, *Witherspoon 8506*; Cerro Jefe, trail running NE from summit, 1000 m, *Mori et al. 3762*. VERAGUAS: Cerro Arizona, above Sante Fe, 1400 m, *Hammel & Kress 8579*.

All collections of *Sphagnum perichaetiale* examined were from mountain summits at or over 900 m. This species in Panama occurs as both an epiphyte and a terrestrial moss. In some localities on the summit of Cerro Jefe, *S. perichaetiale* occurs not only in the crotches of trees (two to four meters up) but also as dense mats beneath those trees.

A number of collections of this moss have been misidentified as *S. magellanicum* (e.g., *Witherspoon 8506*, *Mori et al. 3762*). Although the two species are similar macroscopically (particularly when *S. perichaetiale* takes on a slightly reddish-brown tint), the differences in their branch leaf green cells as seen in cross-section unequivocally separate the two. Crum (pers. comm.) considers the presence of pores on the outer surface of the branch leaves that take up stain to be the best way to separate the two.

2. *Sphagnum magellanicum* Brid.

Descriptions and illustrations: Warnstorf, 1911 (as *S. medium*); Eddy, 1977; Andrus, 1980; Crum, 1980; Crum & Anderson, 1981; Crum, 1983; Crum, 1984.

Specimens examined. DARIEN: Serrania del Darien, Cerro Mali, Pico Mali, 1500 m, *Mori & Gentry 4353*. VERAGUAS: Cerro Tute, ca. 10 mi NW of Santa Fe, above 1000 m, *Mori et al. 7604*. Additional records. BOCA DEL TORO: between Itamut and Fábrega peaks, 3200 m, *L. G. Gómez et al. 22577* (CR).

Terrestrial in Panama, the cortical cells of this species always have spiral fibrils. The chlorocysts of both *Sphagnum magellanicum* and *S. alegrense* are elliptic and completely enclosed in cross-section. Both species also may develop a reddish color. The two differ by the lack of spiral fibrils on the stem cortical cells of *S. alegrense* and the smooth inner side walls of the branch leaf hyalocysts of *S. magellanicum*, as seen in cross-section.

3. *Sphagnum alegrense* Warnst.

Description and illustration: Warnstorf, 1911.

Specimen examined. BOGAS DEL TORO: Cerro Colorado, N of San Felix, ca. 12 mi above Camp Chámi, 8°35'N, 81°45'W, 1400-1470 m, *Allen 5100*.

This collection clearly belongs in Warnstorf's (1911) Subfibrigera group of section *Sphagnum*, a group characterized by the presence of cortical spiral fibrils on the branches only. The assignment of this material to *S. alegrense* is, however, less than satisfactory. *Sphagnum alegrense* is distinguished within the Subfimbrigera group by branch leaf sections showing fully enclosed green cells, and the development of short vermiform ridges on the inner side walls of the hyalocysts. In the Panamanian material cited above the green cells are fully enclosed, but the vermiform ridges on the inner side walls of the hyalocysts are difficult to demonstrate except in longitudinal sections. Crum (1980, 1984) commented on the difficulty in demonstrating vermiform ridges on the hyalocysts of this species and has tentatively suggested a synonomy for the species that gives it a wide neotropical distribution.

This collection is the first report of the species in Panama. The outstanding feature of this moss is its epiphytic habit. It occurs in large masses on the upper crotches and branches of trees (ten to fifteen meters above the ground). When first encountered its aspect is so unusual it can be mistaken for some kind of giant termite nest.

4. Sphagnum meridense (Hampe) C. Müll.

Descriptions and illustrations: Warnstorf, 1911; Crum, 1980, 1984.

Specimens examined. CHIRIQUI: Cerro Colorado, ca. 24 mi above bridge over Río San Felix, 1430-1500 m, *Croat 48493; Antonio 2629*. Additional reports. BOCAS DEL TORO: Headwaters of Rio Colubre, 2400-2500 m, *L. G. Gómez et al. 22421* (CR).

The only representative of section Acutifolia in Panama, this species is easily distinguished from all other Panamanian Sphagna but is complete lack of cortical spiral fibrils, its narrowly truncate branch leaves and its strongly bordered stem leaves.

I am grateful to Dr. H. Crum for his comments and criticisms, and for supplying additional reports of the genus in Panama. I thank Dr. M. R. Crosby for reading an early draft of this manuscript.

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Addition to: Gauthier, R. 1986. Some Sphagna from Great Wass Island, Maine. Evansia 3(2): 17-20. The specimens cited in this paper are deposited at QFA.

The 1987 Andrews Foray will be September 18-20 at Wiscasset, Maine. For information contact Robert Thomas, Department of Biology, Bates College, Lewiston, ME 04240, or to be put on the mailing list Nancy Slack, Biology Department, Russell Sage College, Troy, NY 12180. Students will receive a 50% discount.

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